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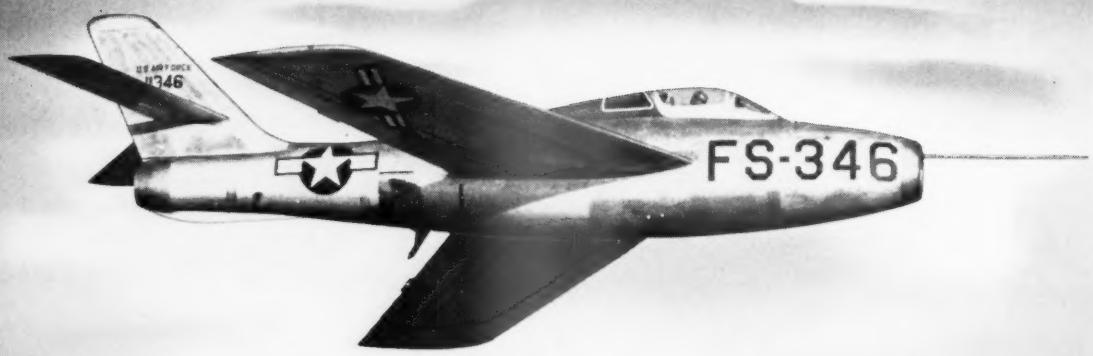
INSTITUTE OF AERONAUTICAL SCIENCES

AUGUST 1953



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AERONAUTICAL ENGINEERING REVIEW

Cover—The H.P.80, designed and produced for the Royal Air Force by Handley Page, Ltd., features a crescent (or scimitar) swept-back wing. This near-sonic bomber is powered by four Sapphire turbojet engines, built by Armstrong, Siddeley Motors, Ltd. Each of the two main undercarriages is equipped with four double-tire wheels. Further details concerning this aircraft and its performance are still included in Great Britain's official secret list.

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IAS News

A Record of People and Events of Interest to Institute Members

Bane and Chanute Awards Presented

B. F. Greene, Jr., and W. B. Bridgeman Receive Bane and Chanute Awards at July 15 Dinner During IAS Annual Summer Meeting in Los Angeles

The Thurman H. Bane Award for 1953

Benjamin F. Greene, Jr., of the Air Force Cambridge Research Center, ARDC, USAF, was the recipient of The Thurman H. Bane Award for 1953 "for the development of an electronic system for airport traffic control which greatly increases the landing rate of aircraft under high density traffic or poor visibility conditions."

Mr. Greene has developed an electronic system that, using radar to follow aircraft, automatically schedules the landing sequence of aircraft approaching an airport. The equipment automatically calculates the time of arrival that the plane would have, if the runway were free, and then determines whether another plane is already scheduled for a landing at that time. If the runway is free, the plane comes in directly. Conversely if it is not free, the system finds the next open time and computes a detour path that will introduce the proper delay. The computed heading instructions are relayed to the pilot by radio.

With this newly developed system, aircraft can approach the landing area in an orderly controlled manner and without the delays inherent in the presently used method of "stacking" aircraft over an airport. Landings for these aircraft can be scheduled at 30-sec. intervals, provided of course that other factors, such as clearing planes from the runway, will allow such close spacing.

The Thurman H. Bane Award, endowed by Major R. H. Fleet, honors the memory of Col. Thurman H. Bane, one of the most prominent technical officers of the U.S. Army Air Corps, who died in 1932.

Benjamin F. Greene, Jr.

The Octave Chanute Award for 1953

William B. Bridgeman, Engineering Test Pilot, Douglas Aircraft Company, Inc., was given The Octave Chanute Award for 1953 "for outstanding contributions to the knowledge of supersonics resulting from flights at recorded speeds and altitudes never before reached in a piloted aircraft."

The selection of Mr. Bridgeman as the recipient of the Chanute Award was a result of his work as Pilot and Engineer, with particular reference to his contribution to the knowledge of supersonic flight as the pilot of the D558-2 Skyrocket.

Mr. Bridgeman received his first training as a pilot in 1940 when he entered the Naval Aviation Cadet Training Program. After receiving his Naval wings and commission, he was sent to the Pacific Ocean Area where he served for the duration of World War II as a patrol plane pilot.

Joining Douglas's Flight Test Division in 1948, Mr. Bridgeman was assigned the following year to the Skyrocket project. Since that time, he has performed all the air-launched research flights in the D558-2. His most famous flight in this rocket-powered aircraft is the one that carried him to a reported altitude of 79,494 ft. and speed of 1,238 m.p.h.

Through Mr. Bridgeman's 60-plus flights in the Skyrocket, data was obtained in a phase of supersonic flight in which no previous full-scale information was available.

The Octave Chanute Award was established by the Institute in 1939 to honor the memory of Octave Chanute, pioneer American aeronautical investigator, who died in 1910.

William B. Bridgeman

Northeast IAS Student Branches Hold First Regional Meeting

The First Annual Northeastern Conference of IAS Student Branches was held on April 10–11 on the campus of Rensselaer Polytechnic Institute, Troy, N.Y. It was attended by approximately 65 students and faculty members from the Academy of Aeronautics, U.S. Naval Academy, Princeton University, The Johns Hopkins University, Massachusetts Institute of Technology, New York University, Carnegie Institute of Technology, The Pennsylvania State College, and Rensselaer Polytechnic Institute.

Registration for the conference took place on Friday afternoon, April 10, and was followed by guided tours of the R.P.I. campus and the Aeronautical Engineering Department facilities.

R. Bruce Forster, Development Engineer in charge of Rocket Research at Bell Aircraft Corporation, was the guest speaker at the Friday evening dinner meeting. Mr. Forster discussed the design problems, power plants, and the developments of the X-1 and X-1A rocket aircraft. He was introduced by Prof. Andrew J. Fairbanks, Associate Head of the R.P.I. Aeronautical Engineering Department, and Faculty Adviser for the R.P.I. Student Branch of the IAS. Films showing the X-1 and X-1A aircraft in flight and the NACA rocket-model flight-test program were shown. Charles L. Lee, Jr., an R.P.I. senior in Aeronautical Engineering, was Chairman of the Friday evening meeting.

Two technical sessions were held on Saturday, April 11. At the morning session, under the chairmanship of Joseph A. Sabatella, Rensselaer Polytechnic Institute's IAS Student Branch Chairman, five undergraduate student papers were presented. The speakers and their papers were: Richard Kuta, Academy of Aeronautics, "The Application of Jet Propulsion to Helicopters"; John Stewart and Maurice F. Gionfriddo, Massachusetts Institute of Technology, "Aspects of Dynamic Wind Tunnel Testing"; Midshipman John P. Sinnott, U.S. Naval Academy, "The Application of Swept-Wing Principles to a Supersonic Axial Flow Air Compressor"; William C. Zeltner and Stanley S. Albrecht, New York University, "Sandwich Construction for Aircraft"; and Robert Skodis, Princeton University, "Employment of Smoke Tunnels in Airfoil High-Lift Device Experimentation."

The second technical session was held on Saturday afternoon. The following graduate student papers were presented: "Experimental Study of the Natural Vibrations of Cantilevered Triangular Plates," by Carl F. Zorowski, Carnegie Institute of Technology; and "A Nozzle for Obtaining Transient Supersonic Flow," by William Guman, Rensselaer Polytechnic Institute.

Following the presentation of the graduate student papers, R. N. Woodham, Administrator of the Cornell-Guggenheim Aviation Safety Center, discussed the latest techniques to improve safety in the air. He cited several examples of how poorly designed equipment caused major accidents. Mr. Woodham was introduced by Professor Fairbanks.

Films of Consolidated Vultee Aircraft Corporation's hydrodynamic model testing were then shown. In addition, the first taxi runs of the delta-wing water-based interceptor, the XF2Y-1 "Sea-Dart," and the initial flight of the XF-92A were shown. A North American Aviation, Inc., film showing the latest aircraft of this company was also shown.

A banquet was held on Saturday night with Conference Chairman Richard J. Wasicko, an R.P.I. senior in Aeronautical Engineering, presiding. A welcome address was made by Dr. Richard A. Waite, Jr., Dean of Students at R.P.I. Professor Fairbanks then announced the winners of the awards for the best student papers. Midshipman John P. Sinnott, of the U.S. Naval Academy, won first prize for the best undergraduate paper, with Robert Skodis, of Princeton University, and John Stewart, of M.I.T., winning second and third prizes, respectively. William Guman, of R.P.I., was awarded the prize for the best graduate paper. The prizes consisted of cash awards and desk models of current Grumman aircraft. Professor A. K. Booth, of the Mechanics Department, R.P.I.; Prof. C. Sanford, of the English Department, R.P.I.; and Milton B. Ames, Jr., of the NACA, served as a Committee of Judges in selecting the winners.

Mr. Wasicko then introduced the banquet's principal speaker, Milton B. Ames, Jr., Chief of the Aerodynamics Division, NACA, Washington, D.C. Mr. Ames presented an interesting and enlightening talk on the topic "Advancing Aeronautical Science—A Challenge." He urged renewed attention to the vital role of research and engineering application in the production of advanced aircraft for both civilian and military use. Mr. Ames stated that "this year the engineering colleges of the United States will graduate only 18,000 students as compared to 32,000 in Soviet Russia," and he said that unless present trends are reversed, the Russians will in 4 years be graduating four times as many engineers as the United States.

M.I.T. extended a tentative invitation to hold the second conference on its campus in 1954. Conference Chairman, Richard Wasicko, then formally closed the First Annual Northeastern Conference.

RICHARD WASICKO
Conference Chairman

R. Bruce Forster, Development Engineer in charge of Rocket Research at Bell Aircraft Corporation *(third from the left)*, is shown giving a manual demonstration of a certain lateral dimension. Watching him, *from left to right*, are: Prof. A. J. Fairbanks, Associate Head, Aeronautical Engineering Department, Rensselaer Polytechnic Institute; Milton B. Ames, Jr., Chief, Aerodynamics Division, NACA, Washington, D.C.; and Richard J. Wasicko, R.P.I. Senior in Aeronautical Engineering and Chairman of the First Annual Northeastern Conference of the IAS Student Branches.

This group picture shows the student award winners at the Third Annual West Coast Conference of the IAS Student Branches. *From left to right,* in the front row are: R. E. Buckland, University of California; D. M. Tellep, University of California; and P. Lamson, California Institute of Technology. In the back row, *from left to right,* are: Lt. (j.g.) W. D. Harkins, USN, U.S. Naval Postgraduate School; Carl F. Branson, University of Washington; Keith Putnam, California State Polytechnic College; and Everett Alford, Oregon State College.

Report of Third Annual West Coast Conference of IAS Student Branches

The Third Annual West Coast Conference of the IAS Student Branches was held on May 7, 8, and 9 at the Ames Aeronautical Laboratory, NACA, Moffett Field, Calif. The major activities undertaken were the presentation of undergraduate and graduate papers, presentation of student awards, tour of Ames Aeronautical Laboratory, plant tour of United Air Lines, Inc., and plant tour of Hiller Helicopters.

In the undergraduate division, the first-award paper was presented by D. M. Tellep and R. E. Buckland, University of California; the second, by Everett Alford, Oregon State College; and the third, by Keith Putnam, California State Polytechnic College. In the graduate division, the first award was given to P. Lamson, California Institute of Technology; the second, to Lt. (j.g.) W. D. Harkins, USN, U.S. Naval Postgraduate School; and the third, to Carl F. Branson, University of Washington.

Each of the student award winners received a monetary prize and an IAS Certificate of Merit. In addition, the first-award winners in the undergraduate and graduate groups were given a Plaque of Merit by Lockheed Aircraft Corporation; the second-award winners received models of Boeing Airplane Company's B-47; and the third-award winners got models of the F-92A from Consolidated Vultee Aircraft Corporation. (The models and plaques were donated by the designated manufacturers.)

The registered attendance at the conference was 78. This was made up mainly of students from the University of California at Los Angeles, California Institute of Technology, Cal-Aero Technical Institute, U.S. Naval Postgraduate School, University of Washington, Oregon State College, University of California, and California State Polytechnic College.

The banquet, held on May 8 at Ramor Oaks, Redwood City, Calif., was jointly sponsored by the San Francisco and Los Angeles sections of the IAS. The awards and certificates for the best student papers were handled by the Los Angeles Section's Sub-Committee on Student Affairs.

The judges of the student papers were: Lester G. Kelso, Development Engineer, United Air Lines; Myles D. Erickson, Head, 7- by 10-Ft. Wind Tunnel Section, Ames; and Winfield H. Arata, Jr., Preliminary Design Engineer, Lockheed Aircraft Corporation. The welcome to the conference attendees was given by John F. Parsons, Associate Director of Ames.

WINFIELD H. ARATA, JR.
Chairman, Sub-Committee on
Student Affairs, Los Angeles Section

Ciba Joins IAS

Ciba Company, Inc., of 627 Greenwich Street, New York 14, N.Y., has become a Corporate Member of the Institute of the Aeronautical Sciences.

The company's Plastics Division is now marketing vinyl-phenolic and epoxy adhesives for the aircraft industry. Included in this extensive line of adhesives is an improved type of Redux. Used in aircraft for more than 10 years, Redux has been the bonding agent for various primary aircraft structures. Those aircraft in which Redux has been utilized include the Chance Vought Corsair and Cutlass, the de Havilland Comet and Dove, the Bristol Britannia, and several helicopters.

Among the epoxy adhesives marketed by Ciba is a group known as Araldite, which complements Redux in its usage. Araldite includes cold- and heat-setting types among which are found both liquid and paste adhesives.

The Ciba organization has available a special aircraft technical service unit that is headed by G. M. Scales. This unit, which reportedly has had worldwide experience with adhesives, is composed of technicians who have received their training under Dr. N. A. de Bruyne, Managing Director of Aero Research Limited, Duxford, England, which is a Ciba subsidiary.

Aero Medical Association Elects Officers

Rear Admiral Bertram Groesbeck, Jr., (MC) USN, Commanding Officer, National Naval Medical Center, Bethesda, Md., was installed on May 13 as the President of the Aero Medical Association. Admiral Groesbeck will preside at the society's twenty-fifth anniversary meeting to be held in Washington, D.C., in 1954. Brigadier General Otis O. Benson, Jr., USAF (MC), Director of Staffing and Education in the Surgeon General's office, was chosen President-Elect. General Benson was the recipient of The John Jeffries Award for 1950, given to him by the Institute of the Aeronautical Sciences "for outstanding contributions to the advancement of aeronautics through medical research."

The following members were elected Vice-Presidents for the coming year: Kenneth E. Dowd, M.D., of Montreal; Andre Allard, M.D., of Brussels; Trajano Bernardo, M.D., of Manila; and E. O. Errebo-Knudson, M.D., of Copenhagen. Chosen to serve on the Executive Council for a period of 3 years are Brig. Gen. M. S. White, USAF (MC), Seymour Fisk, M.D., and Edward J. Baldes, Ph.D., MIAS. Dr. Baldes is Professor of Biophysics at the Mayo Foundation for Medical Education and

Research, University of Minnesota, and Chairman of the Section on Biophysics and Biophysics Research at the Mayo Clinic, Rochester, Minn.

Guggenheim Fellowships at CalTech

The appointment of three new Daniel and Florence Guggenheim Jet Propulsion Fellows and the renewal of six other Fellowships at California Institute of Technology was announced on May 28 by Harry F. Guggenheim, IAS Member, Honorary Member, and Benefactor, President of The Daniel and Florence Guggenheim Foundation, and Dr. L. A. DuBridge President of CalTech.

The new Fellows who were selected to carry programs of advanced study and research at CalTech's Daniel and Florence Guggenheim Jet Propulsion Center are: Robert J. Hartlieb, Jr., of Lebanon, Pa.; Saul Feldman, of Los Angeles; and David M. Benenson, also of Los Angeles. Mr. Benenson is an IAS Student Member who was awarded an M.S. degree in Aeronautics by CalTech this past June.

The six Fellows whose grants were renewed for an additional year are: Odus R. Burggraf, Jr., TMIAS; Donald A. Dooley, TMIAS; Martin Goldsmith; Denver C. Gore, Jr.; Frederick Harshbarger; and Charles A. Lindley.

The Daniel and Florence Guggenheim Jet Propulsion Center at CalTech was established in 1948 by the Guggenheim Foundation to provide facilities for graduate education and research in jet propulsion and rocket engineering with particular emphasis on peacetime uses. The principal post at the Jet Propulsion Center is a Robert H. Goddard Professorship, named in honor of the American rocket pioneer, Dr. Robert H. Goddard (1882–1945). This post at CalTech is held by Dr. H. S. Tsien, FIAS.

News of Members

▸ **Don R. Berlin** (F), President, Piasecki Helicopter Corporation, received an honorary Doctor of Engineering degree from his alma mater, Purdue University, on May 31.

A. E. Russell, FIAS, FRAeS, Chief Designer, Aircraft Division, and Director, The Bristol Aeroplane Company Limited, was one of six British aircraft designers who were honored at a Coronation Year Ceremony of Awards held recently by the Institute of Engineering Draughtsmen and Designers in London, England. Mr. Russell was given an illuminated Honours Diploma by the IEDD President, Lord Westwood of Gosforth, in recognition of Mr. Russell's work as designer of the Bristol Britannia. This diploma is described by the IEDD as "the highest professional honours award, which less than a dozen other engineering designers have won in the past."

▸ **Dr. Clifford C. Furnas** (F), Director, Cornell Aeronautical Laboratory, Inc., served with a mission on a visit to the Long Range Weapons Establishment at Salisbury and Woomera, South Australia, during late April and early May. The trip was designed to review progress of the Australian Guided Missile Program. The mission itself consisted of one USN, one RAF, five USAF, and two USA representatives, in addition to Dr. Furnas who represented the Research and Development Board. Dr. Furnas is Chairman of the RDB's Guided Missile Committee.

Colonel H. Franklin Gregory, USAF, AFIAS, is now serving as United States Air Attaché to the American Embassy in Paris, France. Colonel Gregory was the recipient of The Thurman H. Bane Award for 1943 "for his contribution to the military and commercial development of the helicopter."

▸ **Anthony W. LeVier** (M), Chief Engineering Test Pilot, Lockheed Aircraft Corporation, will be the subject of a biography that has been accepted for publication by Harper & Brothers. The biography will be written in the first person by John Guenther, a former newspaper and magazine writer and editor.

▸ **Glenn L. Martin,** IAS Honorary Fellow, Benefactor, and Founder Member, has announced his retirement from all aircraft activities with The Glenn L. Martin Company. However, he has indicated that he will continue as a company director for an indefinite period before making his retirement complete. He was re-elected to the Martin Board of Directors on May 15.

▸ **Frank N. Piasecki** (F), Chairman of the Board, Piasecki Helicopter Corporation, was awarded an honorary Doctor of Science degree by the Pennsylvania Military College.

▸ **Captain John Laurence Pritchard** (HF), former Secretary of the Royal Aeronautical Society, was one of the 23 recipients of the first Paul Tissandier Diplomas of the Fédération Aéronautique Internationale presented during the Fédération's Congress, which opened at The Hague on last May 15.

Major J. Vivian Holman, MIAS, AFRAeS, who has been associated with the British aircraft industry for well over 30 years, was recently elected to the Board of Redep Limited, of England. He is also a Member of the Board of Bryans Aeroquipments Limited. Major Holman has served for some years on various British committees concerned with civil aviation. In the fall of 1950, Major Holman relinquished all of his executive posts, etc., with Radio & Television Trust Ltd., and its subsidiary companies, of Great Britain.

Members on the Move

The purpose of this section is to provide information concerning the latest affiliations of IAS members. All members are therefore urged to notify the News Editor of changes as soon as they occur.

Mac C. Adams (TM), Aerodynamics Department, Douglas Aircraft Company, Inc. Formerly, Instructor and Graduate Student, Cornell University.

Walter E. Benulis (TM), Senior Aerodynamicist, Republic Aviation Corporation. Formerly, Project Engineer, Air Armament Systems, Sperry Gyroscope Company, Division of The Sperry Corporation.

A. A. Boon Hartsinck (M), Sales Engineering Staff, Lockheed Aircraft Corporation. Formerly, Independent Consultant with own company, Redwood City, Calif.

W. Kenneth Bullivant (M), Senior Aeronautical Engineer, Facilities Operation Division, Ralph M. Parsons Company, Braddock Heights, Md. Formerly, Aerodynamics Engineer, Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation.

Dr. Louis F. Doty (M), Design Engineer, Structures and Aerodynamics Department, Aircraft Armaments, Inc. Formerly, Aeronautical Research Scientist, Lewis Flight Propulsion Laboratory, NACA.

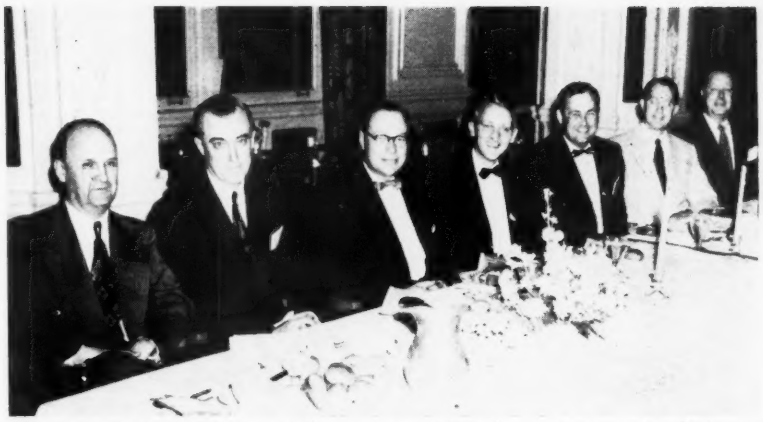
Roger E. Lindenmuth (TM), Associate Engineer, Douglas Aircraft Company, Inc. Formerly, Draftsman "A," Douglas Aircraft.

Cameron N. Lusty (AF), Pilotless Aircraft Consultant, Barnum Hotel, Bridgeport, Conn. Formerly, Vice-President, Aircraft Division, Globe Corporation.

Jack H. Sidebottom (M), Engineering Manager, Flight Refueling, Inc. Formerly, Assistant Director, Technical Services, Aircraft Industries Association of America.

Henry Chess Trich (M), Manager, Proof Division, Parker Aircraft Company. Formerly, General Manager, Valve Division, Proof Industries Corporation.

Major Edmund G. Wodrich, USAF (AF), Chief, Airframe Branch, Aeronautical Standards Group, Departments of the Navy and Air Force, Washington, D.C. Formerly, Chief, Requirements Division, Headquarters, Holloman Air Development Center, Holloman AFB, N.M.



This picture, taken at the Annual Banquet of the 1953 National Telemetering Conference in Chicago on May 20, shows the following persons seated at the head table *(left to right)*: R. S. Gardner, Assistant Secretary, American Institute of Electrical Engineers; Harvard L. Hull, Director, Remote Control Engineering Division, Argonne National Laboratory; Dr. J. E. Hobson, Director, Stanford Research Institute; Kipling Adams, Head, Chicago District Office, General Radio Company; John A. Doremus, Director of Engineering, The Allen D. Cardwell Manufacturing Corporation; W. A. Wildhack, Chief, Office of Basic Instrumentation, National Bureau of Standards, Department of Commerce; and L. G. Cumming, Technical Secretary, Institute of Radio Engineers. Mr. Hull *(second from the left)*, the 1952–1953 Chairman of the IAS Chicago Section, represented the Institute. A total of 305 persons registered at the conference, which was sponsored by the AIEE, IAS, IRE, and ISA. Plans for the 1954 National Telemetering Conference are now being made under the Chairmanship of W. J. Mayo-Wells, of The Johns Hopkins University's Applied Physics Laboratory.

Corporate Member News

• **Aerolab Development Company . . .** The recently announced Contour Sensor, an all-electric contour-duplicating attachment for machine tools, can be attached to the lead screw of almost any machine tool and requires only 110 volts a.c. According to company claims, this attachment may be placed in the tool crib and used on any machine tool as the need arises. The company also says that the unit will trace to the working accuracy of the machine tool. The Contour Sensor contains an electronic sensing unit sensitive to 0.00002 in., mounted in a conventional dial-indicator case. As the indicator deflects from zero, a signal is sent to a portable electronic brain that interprets the signal and sends a power impulse to a small but powerful drive motor, which drives the lead screw just enough to return the work to zero on the indicator. This automatic action is said to replace the eye, brain, and hand coordination of the operator.

• **Aeroquip Corporation . . .** Aeroquip "Globe-Seal" Hose Lines, which can be connected with Ermeto or Ferulok types of flareless tube systems, are now being produced. These Globe-Seal lines are made up with the "Aeroquip detachable reusable fittings, except that the hose-fitting nipple connects with Ermeto or Ferulok tube connectors without the need for ferrules or inserts." This hose line is available in both the single and double wire braid types.

• **Aluminum Company of America . . .** A new building now under construction adjacent to Alcoa's Cleveland Works will house two massive forging presses of a 35,000- and a 50,000-ton capacity each. These two presses are a part of the USAF's defense program. The building, measuring 1,083 by 480 ft., is scheduled for completion near the middle of next year; both presses are expected to be in operation by January of 1955. Alcoa expects to lease from, and operate the presses for, the Air Force.

• **Bendix Aviation Corporation . . .** All of the operations of the Bendix-Skinner Division, now being carried on in four plants scattered throughout Detroit, are

(*Continued on page 54*)

1953 National Telemetering Conference Record

Now Available at $1.50 per Copy

This bound volume contains all of the papers that were presented at the 1953 National Telemetering Conference in Chicago May 20–22. It may be ordered at $1.50 per copy through R. F. Post, c/o The Allen D. Cardwell Manufacturing Corporation, Plainville, Conn.

Editorial

Discussing Discussions

With the Fourth International Conference coming up next month, it would seem appropriate to belabor a point that has been made before in these pages, but which seems in need of repeated attention, to wit—post-paper discussions at technical meetings.

We often refer to IAS meetings as "forums." Some of them are; many are not. Originally, the word meant simply a place, but, since it described a place where citizens gathered to exchange ideas, it is now proper to use the word as a meeting itself. But note the significance of the word "exchange." A forum is not a meeting at which a group of listeners are *told* something. It is, properly, a meeting in which the listeners participate in what is being said. Its purpose is the *exchange* of ideas. Its ultimate objective is to arrive at a meeting of minds.

How often we fail to arrive at a desired objective because the real purpose of the forum itself has not been understood! In all too many of our meetings first-rate papers are rounded off with a scattering of polite applause and a long and awkward silence. Sometimes a chairman will succeed in dragging a few (and obviously reluctant) characters to their feet and sometimes will succeed in getting a good discussion going, but it is seldom self-generated.

We have pointed out before the contrast that has been in evidence at our three prior International meetings. Our British Cousins seem scarcely to permit a speaker to gather his papers and his wits together after closing before they leap to their feet in droves to agree or to disagree with this or that point that has been made. Now this is not always, and of necessity, good. They sometimes seem (to us) to go to somewhat greater lengths in congratulating the speaker and in agreeing with him than the occasion seems to warrant. Be that as it may, the average British engineer or scientist appears to be more at his ease standing on his feet in public discussion than do his opposite numbers from this side. There are exceptions, of course, but the weight of evidence points in that direction.

Why is this so? On the basis of temperament, one might suspect the opposite. It is standard cartoon practice to depict the shy and retiring Britisher vis-à-vis the quick-drawing American extrovert. We should "sound-off" at the drop of a pointer, but we seldom do.

There is, of course, a basic educational difference that may help account for it. In the past, British educational programs have put a great deal more emphasis on what we are inclined to label the "classic" subjects, including proper expressions in the English language—both written and oral. Debating for its own sake is more common practice there than here. We have our

high school and college debating teams, but participation by the technically inclined is the exception rather than the rule. There are indications that we are correcting the difference to a certain extent, not necessarily by promoting debating societies but by encouraging and even *requiring* engineering students to spend more time on the "humanities." The object is to turn out people whose interests are broader then their own immediate fields and who have a capability for self expression. This is good. We are sure that progress is being made and that the next generation of engineers may not be quite so reluctant to get on their feet and argue.

But one difficulty that is ever with us is the question of security. Theoretically, the proper approach to a scientific problem should be on a basis of free discussion, pro and con, with a minimum of inhibition. Unfortunately, under present conditions such freedom of expression is seldom possible. People fear that in the give and take of discussion they may drift over the prescribed line. Sometimes it is not too clear just where the line is drawn. But a security-minded individual should have not great difficulty in realizing where to stop and where to go. There are many areas within the scope of our meeting activities where the problem can be easily resolved. In such cases, we should not seize the excuse of security to throttle any urge that might arise to get up on one's own feet and take part in a worth-while discussion.

The problem of discussion is always with us. It applies to all IAS meetings from Student Branch up to the National and International levels. It might be a good idea for our Section Officers to give some concerted thought to the subject, to talk the problem over in Section meetings, and to make a point of selecting chairmen who are known to have particular talent in provocatively pointing up issues.

One practical thing that can be done at all program planning levels is to allow more time for discussion in meetings. Too often our programs are packed too tightly with formal papers. We can only admit the fault in our National meetings. It is sometimes hard to resist the pressure of "just one more paper" for a session. But we hope we are learning. A good precedent is being set in the Fourth International where but two papers have been scheduled for a morning (or afternoon) period to allow plenty of time for discussion.

During the Third International Conference at Brighton, one or two Americans were conspicuous "ball carriers" in the discussion periods. It is now our hope that more of our delegates will take their cues at the proper time and get on their feet to help make the forthcoming London meeting the most successful yet.

S. P. J.

Official U.S. Navy Photo

The new angled "canted" flight deck of the aircraft carrier, U.S.S. "Antietam" (CV-36), was evaluated during tests off the Virginia Capes in January, when carrier-based planes landed and took off the modified flattop at sea. The "Antietam," shown refueling the destroyer, U.S.S. "Corry," during the period, is the first American carrier designed to use this joint British-American Naval development in Naval carrier operations. Originally designed by the Royal Navy, the new deck will result in greater increases in fighting potential, operational efficiency, economy, and safety to the pilots and flight deck personnel of the ship.

Recent Developments in the NAVY'S AIR ARM

CAPT. J. N. MURPHY, USN*
Bureau of Aeronautics

Introduction

Much is being done to improve performance, to decrease complexity, and to improve the reliability of our aircraft in this supersonic and atomic era that we are entering. Naval aviation, in common with all Air Forces throughout the world, is working hard in these areas. The Supersonic and Atomic Age poses to all of us formidable challenges, but I am glad to emphasize that, as applied to the Navy, these challenges do not appear as insuperable obstacles. On the contrary, all of our research and development to date discloses increasingly the tremendous potential capabilities of United States air-sea power in the extension of its classical characteristics of flexibility, mobility, and vast striking power. The very plenitude of topics that I might deal with makes it a temptation to touch upon all of them with a few words in the shotgun method. However, I believe that it will be more useful to confine my remarks to certain major developments in this advanced age which are peculiar to Naval aviation. Therefore, I will discuss a developing philosophy concerning high-speed seaplanes, the place of the airship in this high-speed era, and a new development in carrier aviation which will have a most significant and important effect on this vital weapon in our arsenal for national defense.

Speech given before the Cleveland-Akron Section, IAS, February 17, 1953.

* Executive Director for Research & Development.

Water-Based Aircraft

Seaplanes as we have thought of them were relatively slow and difficult to service and handle as compared to landplanes. However, there are some vital facts about the water basing of aircraft which it would be well to review. The protected water areas, located along coast lines, as well as inland, which are suitable for water-based operations are numerous. The vast ocean areas are, of course, not especially smooth landing fields all of the time, but, if high-performance aircraft could be developed to operate from the ocean surfaces even for a percentage of the time, the flexibility and mobility afforded would be great indeed. The thought of basing seaplanes from relatively small ships, of refueling from submarines in the open ocean, and of operating from harbors, inland lakes, and rivers without fear of having the landing strip destroyed by an enemy is stimulating. Water basing holds forth the potential of unlimited bases with practically indestructible runways, of unusually flexible operations, and perhaps of unusual economy, too.

To develop first-rate aircraft that are water-based required much more than the relatively small yearly percentage improvement in aerodynamic performance characteristic of the steady progress in landplanes. A large jump in aerodynamic performance was mandatory if the seaplane were to compete in the air. During the past 6 years, Naval research has emphasized development projects that would combine clean aerodynamic forms with good hydrodynamic configurations. Model tests in seaplane towing tanks, as well as wind tunnels, design studies, and even flight tests of a variety of hull forms on a small J4F Grumman Widgeon seaplane, were utilized in the quest for improved seaplane hull designs.

Radical departures from the ordinary seaplane development programs were also investigated. The possibility of utilizing retractable water-ski gear was emphasized. Every modern research tool was utilized, including installing and testing of water skis on existing aircraft. More than one means of water basing high-speed aircraft was found. The use of planing tail hulls in combination with jet engines allows the use of slim aerodynamically refined hull forms. In addition, water ski alighting gear of a variety of forms has been shown to be feasible. The skis are used for take-off and landing, but in the air they may be retracted into a streamlined fuselage. Both the extended afterbody type of hull and the ski alighting gear represent marked advances for rough-water operation, because they reduce the tendency of bouncing violently during take-off or landing. In addition, the skis may by mounted on shock struts to reduce hydrodynamic impact loads. At this time the delta-wing XF2Y seaplane fighter, which represents the first Naval high-speed jet seaplane, is undergoing high-speed taxi tests at San Diego, Calif.

A most troublesome phase of the Navy's high-speed seaplane development program is that of beaching and launching. Present means of beaching are difficult and time consuming and are considered unsatisfactory for fighter-type operation. One solution to this problem has been found in conjunction with ski alighting gear. Small wheels may be installed in the skis which permit automatic beaching and parking without the aid of beaching gear or beaching crews. The operation of existing aircraft with small beaching wheels in the skis has demonstrated the great ease with which such aircraft may be operated from a ramp and, in some cases, even from the beach itself.

The challenge of developing high-speed seaplanes has been great, and the Navy's research effort has had to resort to radical departures from conventional design. The practical use of the designs that have been developed has, of course, not yet been fully demonstrated, but it seems safe to look to the future for water-based aircraft with excellent aerodynamic performance, improved water take-off and landing characteristics, and simplified beaching and ground-handling properties.

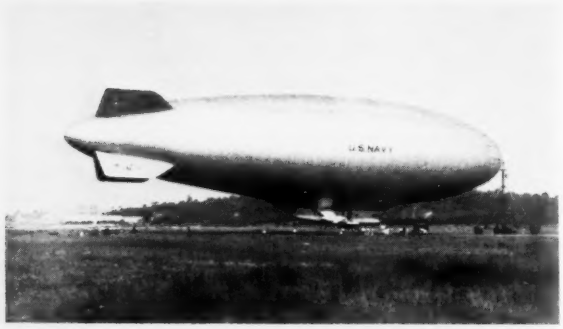
Airships

I will now touch on the use of airships in the Navy, since it is certain to be of especial interest in this area. In the Atomic Age a real threat to our security can be the submarine-launched guided missile with an atomic warhead. The Navy's major mission is that of combating the submarine in all its operations against the United States, including the possibility mentioned above. It is interesting to note that in the Supersonic Age there is still a requirement to go slowly. One does not look for a collar button by running a hundred-yard dash. Therefore, in combating the submarine we must cruise at speeds that are compatible with the detection devices that are now available and which are under development. Naval aviation uses against the submarine conventional aircraft, both of the carrier-based and the land- and sea-patrol types, as well as helicopters and airships. Each of the types mentioned above has its advantages, but all have the common purpose of detecting a modern submarine. Significant progress is being made in all types, but, since World War II, significant advances have been made in the development of new airships. These new airships will be bigger, they will have longer range, be somewhat faster, but, above all, be capable of carrying great quantities of the equipment that is essential to search out modern submarines. These airships will be much less subject to weather limitations, and we hope that they will be able to stay in the air above our convoys in all but the worst possible weather. These new airships will be capable of not only searching out but killing the modern submarine. We have developed techniques for landing the airship on even our smallest carriers and can thus refuel and reprovision them at sea, which will permit them to operate with convoys far from their normal shore bases.

The Canted Deck Concept

We now come to a development that I feel will make the aircraft carrier particularly well adapted to handle the aircraft of the future. This is the canted deck concept. The modern aircraft carrier, called upon to operate aircraft that are rapidly growing in weight and performance, requires a difficult balance in launching,

The Convair XF2Y-1 experimental jet seaplane is equipped with hydroskis for better rough-water landing and take-off performance.



Official U.S. Navy Photo

ZPN-1 airship built by The Goodyear Tire & Rubber Company.

landing, and handling capabilities. Her catapults, arresting gear, and airplane elevators, in particular, must be mated to the most demanding of the various types of aircraft which she will operate. Within the limitations of her fixed flight deck length and within the established ship stability criteria, the provision of adequate equipment for flight operations of advanced aircraft is a serious problem and one which in many cases leads to a compromise with other ship features that have not heretofore been encroached upon.

The canted deck seems, at least in part, to be the answer to the problem. Let us trace the history of this development. During a conference with a British Admiralty exchange team in the fall of 1951, the deck layout of the new Forrestal-class carrier was under discussion. One of the members of the British team remarked that the extension of the flight deck at the port and starboard sides closely followed a new type of landing area conceived and proposed by L. Boddington, of the Royal Aircraft Establishment, and Capt. D. R. F. Cambell, D. S. C., Royal Navy. The personnel of the Ships Installations Division, Bureau of Aeronautics, under Capt. Sheldon W. Brown, USN, recognized this suggestion as having great promise as a possible solution to many of the problems confronting carrier operations in the supersonic era.

Instead of landing aircraft straight up the centerline of the ship, the British proposal was to land the aircraft diagonally across the deck. This would be accomplished by angling or canting the centerline of the landing area 8 or 10 deg. to port of the centerline of the ship.

On the conventional carrier deck the landings are straight up the deck, and the maximum practicable number of arresting wires and barriers is installed in the ship to provide the greatest possibility of arresting the landing aircraft and to afford maximum protection to personnel and aircraft on the forward part of the flight deck. On Essex-class carriers there are 13 arresting wires, five barriers, and one barricade, with a total of twelve arresting engines.

With the canted deck, the great number of arresting wires and barriers is not required. If a pilot fails to engage an arresting wire, he simply takes off and comes around for another pass. Therefore, only six arresting wires are installed in a canted deck landing area. It will be noted that there are provisions for an emergency barricade for jet aircraft and two emergency wire barriers for propeller aircraft. Under normal operations they will not be erected. In the event of a hook mechanism becoming inoperative, the barricade or barriers, as required, will be raised for an emergency arrestment of the aircraft. The radical reduction in the number of arresting wires, barriers, and arresting engines required for the canted deck will not only give a substantial saving in topside weight of the carrier but also produce a great saving in the cost of flight deck equipments and installations.

In addition to the weight and complexity which will be saved in the carrier, there is the possibility of reducing the weight and structural complexity of the carrier aircraft. With jet aircraft, the structural strength supplied in order for the aircraft to sustain a Davis barrier crash will no longer be required. With the extra landing area available, longer runouts of arresting wires are permissible, resulting in lower stresses being applied during an arrestment. Utilizing the "power-on" landing and new approach technique, much lower vertical sinking speeds should be realized. This will result in reduced initial stresses and shock on landing impact and, consequently, reduced strength requirements in the aircraft.

Since the potentialities of the canted deck concept appeared excellent, preliminary tests were conducted at sea. "Touch and go" landings with various types of aircraft were made straight up the deck on the U.S.S. "Wasp" in March, 1952, to develop approach techniques and to test out "power-on" landings. With "power-on" landings, approximately 70 to 80 per cent power is maintained on the jet engines until after touch-down or until a wire has been engaged. There are definite advantages in using a "power-on" technique in landing swept-wing aircraft because of their high angles of attack in the landing attitude. The vertical component of the engine thrust is a significant part of the airplane's lift and should be maintained until contact with the deck is made, if a hard landing is to be avoided. "Power-on" landings are not possible with barriers, barricades, and parked aircraft in front of the landing airplane. However, during the Wasp tests, the use of "power-on" landings with jet-propelled aircraft proved not only feasible but appeared to be particularly well suited to the canted deck concept of carrier landings.

The success of the Wasp tests led to further evaluation. A simulated canted deck was painted on the existing flight deck of the U.S.S. "Midway" in May, 1952. The arresting wires were removed and the aircraft made "touch and go" landings diagonally across the existing flight deck. Tests were conducted using the "power-on" technique for jet-propelled aircraft. The conventional landing technique, in which a pilot "cuts" his throttle after receiving a cut from the landing signal officer, will be required with propeller-driven aircraft. Future tests will firm up the "power-on" and "cut" techniques to be employed with each type of airplane.

However, the Midway tests substantiated the operational feasibility of the canted deck and confirmed the results obtained by the British Admiralty in similar tests. Both Fleet and Naval Air Test Center pilots participated in these preliminary tests aboard the Midway. The majority of the pilots and the flight deck crews, as well as the observers, were enthusiastic over the potentialities and implications of the canted deck concept.

Since the Wasp and Midway tests were successful, the decision was made to carry out a full-scale test and evaluation of the canted deck concept. To accomplish this, the flight deck of the U.S.S. "Antietam" was modified in the New York Naval shipyard during the Fall of 1952 to provide the canted deck area. Under the direction of the Bureau of Ships, this project was completed in remarkably short time. The Bureau bent every effort toward making the Antietam available at the earliest practicable date to carry out the tests that are so important to Naval aviation of the future. The Antietam put to sea in January of this year, and the tests aboard her are now under way.

Because of the short time available for the conversion, many features that may be incorporated in the canted decks of the future had to be improvised in the Antietam. An angle between the centerline of the ship and canted deck of 8 deg. and 9 min. was chosen for the initial tests. However, it is planned that various angles will be tested during the trials. There were six landing wires installed perpendicular to the axis of the canted deck. The deck sheaves were modified and idler sheaves placed on the forward three wires to cut down on the span and the tendency toward off-center landings. A triangular strip of deck was added to the port side as the forward extension of the landing area. Since the deck extended 15 ft. beyond the elevator, the elevator for these tests was fixed in the up position. In future installations the elevator will be operable. With the additional strip of deck, the landing area on the Antietam became 75 ft. by 525 ft., which gives approximately a 20 per cent increase in the usable length of the landing area. A triangular strip of deck was also added to the aft end of the landing area to square off the deck with relation to the axis of the canted deck.

Let us examine in some detail the operating and related design features that can be derived from this concept.

Safety Features.—The landing areas of the canted deck layouts have no obstructions or parked aircraft forward in the direct path of a landing airplane and should, therefore, greatly reduce the hazards associated with present landing operations. This arrangement would completely eliminate the severe types of flight deck crashes that result from airplanes jumping over the barriers and from aircraft penetrating the barriers and barricades because of excessively high engagement speeds. In addition, the hazard of loose rockets and inadvertent triggering of machine guns will be eliminated.

Psychological Effect.—No longer does the pilot have to face barriers, barricades, and parked aircraft as he approaches for a landing. With the canted deck, the pilot, failing to engage an arresting wire, has ample room to take-off and go around for another attempt. A missed engagement results in nothing more serious than a simple "touch and go" landing. The disturbing thought that something may go wrong and result in a barrier engagement or a serious crash into the parked aircraft will no longer exist. This is particularly applicable to night carrier landings. The hook bounces or faulty landings that used to result in the clang of the crash alarm should now be just another pass to be improved on in the next landing. The new pilot, or old pilot requalifying, may make several "touch and go" landings to iron out his approach technique and get the feel of the aircraft in the canted deck approach before he is arrested by the landing wires. The safety features of the canted deck have an excellent psychological effect on the pilots: From their point of view, these are vital factors. The pilot of the landing aircraft is not the only one who benefits by the canted deck. The flight deck crews also benefit. These personnel park and service the aircraft that have landed and are frequently required to be on the forward flight deck while aircraft are landing. For these men, the canted deck is the best carrier innovation in 20 years of operation. No longer will they need to worry about the landing aircraft while they go about their duties. Thus, the time to service the aircraft can be reduced.

Operating Technique.—Tests conducted to date indicate that the optimum condition for approach and landing is with the relative wind directly down the centerline of the canted deck. This situation can be easily obtained by proper adjustment of ship's course and speed. Once in the groove, if the pilot maintains the heading of the aircraft along the axis of the canted deck, the track of the aircraft with respect to the ship will always coincide with this axis regardless of variations in approach speed. The aircraft will land neither in a cross wind nor a skid; therefore, this approach and landing technique is no more difficult than the present. However, with surface winds less than 4 knots it is impossible to obtain a relative wind of 25 knots or greater down the canted deck axis. In the worst condition, which is a dead calm, the relative wind is from dead ahead: Therefore, the pilot is required to maintain a heading slightly to the right of the canted deck axis in order that the track of the aircraft with respect to the ship be maintained along the axis. This condition is never worse than landing in a 10° cross wind from starboard and presents no difficulty as demonstrated by actual tests.

Power-On Landings.—A power-on type of carrier landing is required with jet aircraft for canted deck landings. With power-on, the turbine continues to run at high r.p.m., corresponding to 70 to 80 per cent power, thus facilitating rapid attainment of take-off power in case a wire is not engaged. In addition, this technique is visualized as being necessary when landing highly swept-wing aircraft that assume a very high angle of attack when in the landing attitude. In this

attitude the vertical component of the engine thrust is a significant part of the airplane's lift and must be maintained until contact with the deck in order to avoid a hard landing.

Tests to date have also indicated that the vertical sinking speeds now encountered in carrier operations can be halved with the new landing techniques on the canted deck.

Increased Launching Capabilities.—It has been demonstrated that reciprocating aircraft can take-off from the canted landing area while jets are being launched from the two forward catapults; with the canted deck the launching intervals should be reduced, which will contribute to a longer mission time. There is also the possibility of installing an additional catapult in the canted landing area, which would also decrease the launching time for a given number of aircraft.

Lighter Weight Aircraft.—Another dividend is the reduction in aircraft weight by elimination of the necessity for designing the aircraft structure to accept barrier loads. Further weight-savings may also be expected through adoption of the canted deck, since this arrangement especially lends itself to the use of longer runout arresting gear and, consequently, lower arrested landing strength requirements. These, coupled with a much lower strength requirement due to lower vertical rates of descent, have the potentiality of a substantial weight-saving in the aircraft.

Shorter Landing Interval.—It is anticipated that the canted deck arrangement will result in shorter landing intervals. Instead of an arrested airplane being required to taxi to a position forward of the barriers and barricade in order to clear the deck for the next airplane, the airplane need be taxied only a short distance to starboard to clear the deck.

In addition, the time now expended in clearing the deck and rerigging barriers and barricades following barrier crashes is greatly reduced. (We do not have such barrier crashes frequently, but it is a contingency that must be provided for in planning the reserve of fuel a formation must have upon return to the carrier. Faster clearing of the deck is an extremely important advantage in landing a jet air group because of the shorter endurance of this type of aircraft.)

Conclusion

The problem of increasing the effective group loiter time is becoming more and more important with faster jet aircraft in production and the even faster ones in the experimental stages. The canted deck will definitely be a step in the right direction in solving this problem. Tests conducted to date, with personnel relatively inexperienced in this type work, indicate that the time needed to land an air group on board may only be about one-half that required at present. This means that, since the last plane aboard must have a certain minimum "loiter" time, the group need not arrive over the carrier as soon. If the Antietam tests live up to their expectation, great relief in this area should result. Some of our older carriers, which today have reached the limit of their "elasticity," will be revitalized for many more useful years of life, and our new ones will be provided an added margin of operational capability which will permit a most desirable and necessary continuing advancement in naval aircraft performance.

The introduction of the barricade, the successful development of increased capacity arresting gear, the adoption of the steam catapult with its increased capacity, and the potentialities of the canted deck have guaranteed for carrier aviation greater operational capabilities than it formerly enjoyed in the days of the reciprocating-engined aircraft. With the introduction of these new developments into the fleet, carrier aviation should attain a new striking potential and flexibility not previously thought possible. The canted deck is another milestone in Naval aviation and should begin a new era in carrier operations.

In conclusion, the developments mentioned are a few that will ensure for Naval aviation a healthy and productive future in national defense and will guarantee that the proud record achieved in World War II, and over Korea, will be maintained in the years to come.

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The Status of
The Turbine-Powered Transport
in the United States

FREDERICK B. LEE*
Civil Aeronautics Administration

IN THIS DISCUSSION, I shall outline what the United States Government, and particularly the CAA, has done and is doing in the field of civil turbine-powered transport development in the United States.

The past history is shown in chart form in Fig. 1.

As early as April 17, 1945, the Air Coordinating Committee was confronted with the problem of finding suitable means of fostering the development of new models of large commercial transport aircraft. The first committee study of the problem was completed on February 13, 1947. The second and final study (ACC 13/1.2), completed over 5 years ago and dated November 4, 1947, pointed to the developments under way in foreign turbine transport aircraft, the absence of development of any new types of transports in the United States, the high cost of developing new transports, and the importance of civil transports as a military reservoir.

Also, during 1947 the Congressional Aviation Policy Board and the President's Air Policy Commission, the latter generally called the Finletter Committee, made their comprehensive studies. Of particular interest in connection with our subject are two recommendations, one by the Congressional Board to the effect that "the Federal government should sponsor the development of prototype transport and cargo aircraft..." and the other in which the Finletter Committee recommended that "new types of transport planes be operated regularly...before passengers are carried... to permit mechanical or design weaknesses to become apparent...."

The Congressional Board also recommended the establishment of an interdepartmental Civil Air Transport Evaluation and Development Board. Such a group was temporarily established in 1948, and from their studies came valuable reports on air cargo potential, cost recovery, and the Prototype Aircraft Report of January, 1949, which incorporated, in addition to a considerable amount of data on air cargo perishables, the first objective specifications on 30,000- and 50,000-lb. payload cargo airplanes and a jet transport.

Recommendations of the Congressional and Finletter reports resulted in the passage of Public Law 867, which became effective on September 30, 1950. This is enabling legislation that authorizes the expenditure of $12,500,000 over a 5-year period for testing that would aid in the development of improved transport aircraft in the interests of safety, economy, and the national air transportation system. Funds twice have been requested to carry out the provisions of Public Law 867, but in both instances the Congress made no appropriations.

Concurrent with the legislative and Air Coordinating Committee work, the CAA, beginning as early as 1946, began informal discussions with ICAO and the industry on some of the many problems on airworthiness, operation, airports, and airways, which would be encountered when turbine-powered aircraft are put into civil transport operation.

In 1947, a number of CAA pilots received training and were checked out in F-80 fighters.

A CAA engineering test pilot spent almost all of 1948 in England in the Empire Test Pilots Course, in which there was an opportunity to fly a number of different turbine-powered aircraft.

Starting in 1949, through the cooperation of the Canadian Department of Transport and A. V. Roe Canada, Ltd., the CAA has had the opportunity to observe and participate in phases of the development and testing of the Avro Jetliner.

In fact, the current plans of the CAA for operations under Public Law 867, contingent, of course, on the availability of funds, contemplate the use of the Jetliner during the next year to obtain data on airworthiness and operation of turbines.

That year (1949) also saw the first CAA seminar on turbine transport aircraft. This was intended to acquaint CAA personnel with some of the problems that must be solved before turbine-powered aircraft can

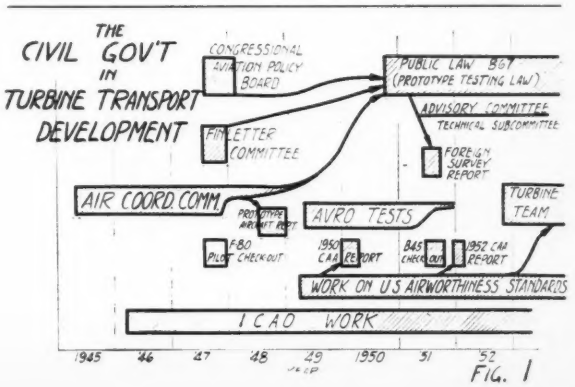
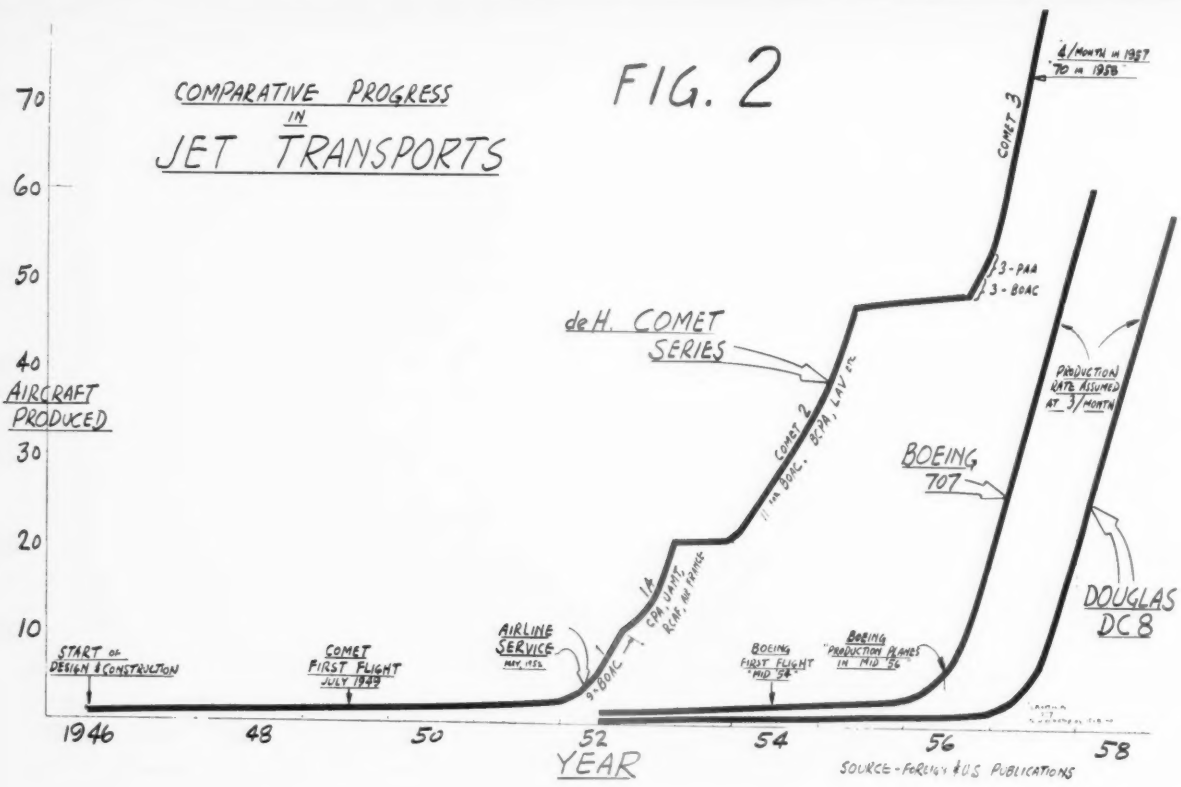
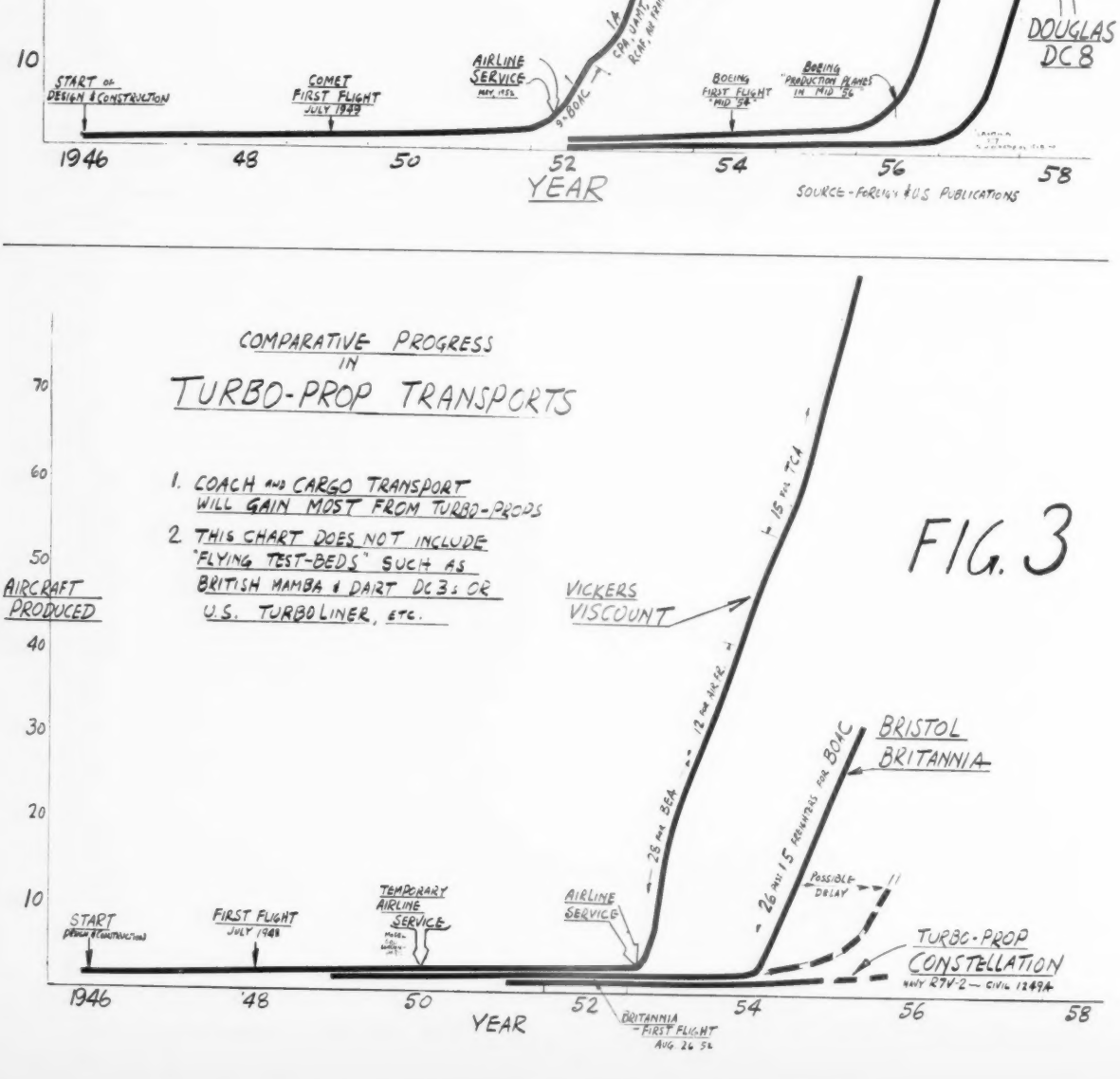


FIG. 1

Presented at the Washington, D.C., Section, IAS, February 3, 1953.

* Deputy Administrator.


COMPARATIVE PROGRESS
IN
JET TRANSPORTS
FIG. 2
AIRCRAFT PRODUCED
70
60
50
40
30
20
10
START OF DESIGN & CONSTRUCTION
COMET FIRST FLIGHT JULY 1949
AIRLINE SERVICE MAY, 1952
9 BOAC
1A CPA, JAMT, RCAF, AF FRANCE
COMET 2 11 FOR BOAC, BCPA, LAV ETC
de H. COMET SERIES
COMET 3
4/MONTH IN 1957 TO IN 1958
3 - PAA
3 - BOAC
BOEING FIRST FLIGHT "MID '54"
BOEING PRODUCTION PLANES IN MID '56
BOEING 707
PRODUCTION RATE ASSUMED AT 3/MONTH
DOUGLAS DC 8
1946
48
50
52
54
56
58
YEAR
SOURCE - FOREIGN & U.S. PUBLICATIONS


COMPARATIVE PROGRESS
IN
TURBO-PROP TRANSPORTS
1. COACH AND CARGO TRANSPORT WILL GAIN MOST FROM TURBO-PROPS
2. THIS CHART DOES NOT INCLUDE "FLYING TEST-BEDS" SUCH AS BRITISH MAMBA & DART DC 3's OR U.S. TURBOLINER, ETC.
FIG. 3
AIRCRAFT PRODUCED
70
60
50
40
30
20
10
START
FIRST FLIGHT JULY 1948
TEMPORARY AIRLINE SERVICE
AIRLINE SERVICE
VICKERS VISCOUNT
~ 15 PAX TCA
~ 25 PAX SEA
~ 12 PAX HP.R.P.
~ 26 PAX 15 RETURNS FOR BOAC
BRISTOL BRITANNIA
POSSIBLE DELAY
TURBO-PROP CONSTELLATION
NAVY R7V-2 — CIVIL 1249A
BRITANNIA - FIRST FLIGHT AUG 26 52
1946
'48
50
52
54
56
58
YEAR

safely be integrated into civil air transport. This seminar was followed in April, 1950, by the first CAA report on the problems relating to the airworthiness requirements for jet transports. This report formed the basis for the paper on turbine-powered transport airworthiness standards which was delivered by the chief of CAA's Aircraft Engineering Division before the Annual Summer Meeting of the Institute of the Aeronautical Sciences at Los Angeles in July, 1950.

In the latter part of 1950, a number of CAA pilots received training in B-45 jet bombers, and the CAA plans for functioning under Public Law 867 were formulated. Intensive study of the B-45 testing performed by General Electric at Schenectady gave additional emphasis to the importance of getting work under way on further developments in navigational and communications aids.

The CAA's Prototype Aircraft Advisory Committee with its high-level representation from Government and Industry was established in 1951 and commenced a series of meetings. Also, its Technical Subcommittee started work. A survey of foreign transport aircraft was made by the Foreign Survey Group, a six-man Government-Industry group. A standing committee on aircraft performance was established in ICAO, and the United States members have been meeting almost daily during the past year for the development of a rational approach to performance which will be applicable to both piston- and turbine-powered aircraft.

In January, 1952, the CAA issued a report entitled, *Proposed Policies on Airworthiness Requirements for Certification of Turbine-Powered Transport Airplanes*, which was developed from the 1950 report and included the best lessons gained from the rapid developments that had taken place during the period.

During 1952, the activity of United States aircraft manufacturers in the development of turbine-powered transports accelerated greatly, and last November, to facilitate meeting the responsibilities of the CAA, the Administrator, Charles Horne, took an important step in establishing a Turbine-Powered Transport Evaluation Team under the chairmanship of George W. Haldeman and including CAA experts in airworthiness and operations. The purposes of the team are:

(1) To assure uniformity in handling type certification of turbine-powered transports.

(2) To develop CAA criteria and policies on type certification and operation, including aspects of airways, airports, and communications.

(3) To carry on the activities assigned for prototype aircraft testing under Public Law 867.

(4) To make the team a central source of information on turbine-powered transport developments.

Much has been written and said about the progress of foreign nations, particularly Britain in the development and use of turbine-powered transports. The Comet, the Viscount, and the Britannia in particular present a real challenge to American industry. No one can question our own great progress in the development and operation of military turbine-powered aircraft, particularly jets. However, in civil transport we are only starting.

Figs. 2 and 3 provide a general comparative picture of United States and British turbine-powered transport development based on published statements. I feel that these charts provide an important key to the problems that CAA will face in the coming 5 to 10 years in approving turbine-powered aircraft and establishing safe and efficient procedures and standards for their operation.

First, it is obvious that despite our tremendous effort in developing and operating military turbine-powered aircraft, we are only beginning to get under way on civil transports.

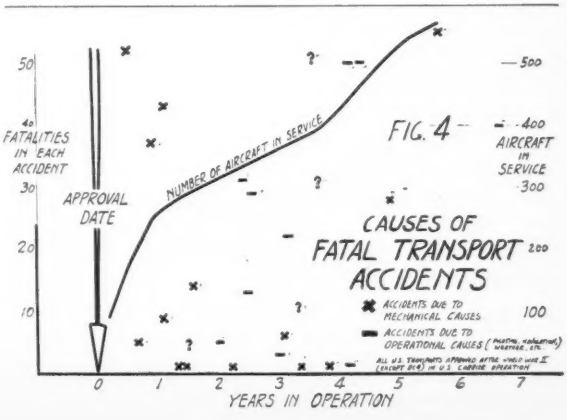
Second, it will be several years before we obtain any experience on a United States-built civil jet transport and probably close to 5 years before such aircraft will go into regular operation.

Third, comparatively little is being done in the United States toward exploiting the turboprop power plant for cargo, coach, or feeder airplane work.

The accumulation of foreign experience and our own delay will tend to focus increasing prestige and economic and technical pressure on United States manufacturers, operators, and the CAA to accelerate the starting date of United States turbine transport operations.

Fig. 4 shows the fatal accidents that have occurred in United States air carrier operation to transport aircraft that received civil approval after World War II. The Douglas DC-4, which technically also comes in this category, has been omitted because of the large amount of development and experience gained during its military use.

Note the preponderance of accidents chargeable to mechanical failure early in the operational history of the aircraft. These aircraft differed from the prewar DC-3, Lodestar, and Stratoliner principally in having more complexity, greater size, and greater speed. But our lack of design "know-how" let us down. Our crystal ball was not big enough or clear enough to let us anticipate and avoid all the serious troubles we encountered.



How much more important it is, then, that in making a fundamental change from piston to turbine power we gain and make use of all the experience we possibly can.

Implementation of the provisions of Public Law 867 would allow us to make substantial progress in that direction, and the establishment of the Turbine-Powered Transport Evaluation Team by CAA Administrator Charles Horne is another constructive step.

Having given you the background on the Government side of this civil turbine-powered transport development, I should now like to devote the few remaining minutes to a brief description of a few of the principal problems that face us in establishing safe and efficient transportation with turbine-powered transports.

Mach Number Limitations.—An important problem in connection with the commercial operation of jet transports will be the establishment of the speed margin necessary between that used in normal operation and the maximum value that will be demonstrated in the CAA certification tests. A jet transport is most efficient when operating at high speed and high altitude. However, there must be an adequate margin to take care of the effect of the normally expected degree of deterioration during the service life of the aircraft, the extent of inattention of, or distraction to, the pilot, turbulence, and other effects. The problem is one that has not been experienced to any great extent with piston-powered transports, because the available cruising power provides a realistic limitation on the normal operating speed.

The extent of this margin will have a direct effect on the required structural strength of the aircraft and upon its economic efficiency.

Explosive Decompression.—Explosive decompression is a newspaper headline way of referring to the problem of sudden loss of cabin pressure. Turbine-powered transports, particularly those with turbojet engines, will probably cruise at altitudes 40,000–50,000 ft. Medical research, as well as our current operating practice, indicates that pressurization or supplementary oxygen should be used when we operate above 8,000–10,000 ft. Hence, airplane cabins will be pressurized in order to hold the cabin altitude below 8,000 or 10,000 ft. with the aircraft operating at 40,000–50,000 ft. Completely dependable cabin pressurization must be developed. This includes not only the primary skin and frames and other structure of the fuselage but also the pilot's windshield with its large expanse of glass, the cabin windows, doors, and emergency exits. All of these components must be designed and tested so as to have day-in, day-out dependability against working pressures of 8–10 lbs. per sq.in.—that is, pressures that approach $^3/_4$ ton per sq.ft. This must be achieved without imposing undue weight penalties.

In case of failure of cabin pressurization, there is the critical danger of anoxia to the aircraft occupants. Oxygen must be immediately available and a rapid descent to lower altitudes started. The range of the jet transport is greatly reduced when it is operated at low altitudes. It is obvious that a failure in the cabin pressurization system or of a window on a jet transport in mid-Atlantic would force it to descend to such a comparatively low altitude that its ability to reach land would be seriously jeopardized.

Navigational and Communications Problems.—The various types of markers used for navigational fixes, such as those used to mark range stations, intersections, and ILS check points, fan out with an increase in altitude. Hence, it is possible for an aircraft operating at 35,000–40,000 ft. to hear several markers simultaneously. The ADF indication may also become meaningless in such a case. The fanning out of the area of no indication from both L/MF and VHF radio ranges with altitude also prevents accurate "over" fixes from being obtained. Hence, an inaccuracy in location will be compounded with the problem of very high-speed flight to make it extremely difficult to obtain accurate navigational information. There is a need to develop a much narrower marker indication to be used for high-altitude navigation. It may be that DME will provide the biggest single aid to high-speed high-altitude navigation since it measures the slant range to the transmitting station itself.

High-altitude communications have still other drawbacks, in both the medium frequency and the very high frequency ranges. The short waves generated by VHF transmission have some of the characteristics of light rays in that they travel in a relatively straight line. They also suffer very little attenuation, or weakening with distance, and, hence, as altitude is gained, a greater number of stations is received and greater is the possibility of interference with other stations on the same frequency.

Aircraft Deceleration.—The development and use of reversing propellers have greatly aided in solving the problems of deceleration with our present transports, particularly under conditions of wet or icy runways. The jet transport, of course, cannot make use of this development. The problem with the jet is further complicated by the substantial residual thrust of jet engines that must be idled at high rotational speeds in order to permit rapid acceleration to full thrust in case a landing is balked.

Various emergency stopping means and nonskid wheel-brake mechanisms will probably assist in the routine landings. However, thoroughly reliable means of decelerating a jet transport, regardless of the runway surface condition, is an operational "must."

The recently proposed method of bleeding compressor air from the engine and using this air in a forward acting jet may have merit.

Noise.—A problem that continues to become more critical with respect to both military and civil operations is that of noise. The amount of noise generated by an aircraft engine is roughly a function of its power. Turbine engines contemplated for transport aircraft will develop greater power than piston engines and are more

DE HAVILLAND "COMET" 4 GHOST TURBO JETS GROSS WEIGHT 105,000 LBS.

A. V. ROE "JETLINER" 4 ROLLS ROYCE DERWENT 5 TURBO JETS GROSS WEIGHT 65,000 LBS.

VICKERS "VISCOUNT" 4 ROLLS ROYCE DART TURBO PROPS GROSS WEIGHT 59,000 LBS.

BRISTOL "BRITANNIA" 4 BRISTOL PROTEUS III TURBO PROPS GROSS WEIGHT 150,000 LBS.

difficult to muffle. In fact, no straightforward solution has yet been proposed.

One faint ray of hope may come with the development of the ducted fan or by-pass turbine engine. As the jet-engine compression pressures and temperatures increase, the thrust is obtained by a higher velocity jet with a reduction in mass flow. From the standpoint of civil transport aircraft, it can be shown that it will be extremely helpful to increase the mass flow. This may be done by permitting part of the flow to by-pass the combustion cycle. The by-passed air leaves the jet pipe as a ring of relatively cooler and lower speed gas flow than that of the central jet stream, and, from this surrounding blanket of cooler and slower flow, we can expect that there will result some reduction in noise intensity.

The lack of clear-cut answers to the noise problem at this time emphasizes the great importance of doing more to solve this vital problem in civil aviation.

These and many other problems face the industry and the CAA. We are confident that they can be solved. Our only real concern at this late date is the time required for their solution.

I hope that from this brief discussion I have been able to present to you at least an overall picture of what we in the Government side of civil aviation have done and are doing. We are appreciative of the assistance we have had from the armed services, the industry, and foreign sources in our work thus far. We are ready and interested in cooperating with others to the end that the change to turbine power in civil aircraft can be done safely, efficiently, and economically.

Turbine-Powered Commercial Aircraft

ADM. DeWITT C. RAMSEY, USN (Ret.)*
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AT THE OUTSET I would like to delve a bit in transport prototype history.

Shortly after the war, when our aircraft production took a nose dive and it looked as though our industry were on the rapid road to ruin, interest became focused, in Congress and elsewhere, on the British leadership in the jet-transport field, and measures involving Government assistance were devised to assist us to close the gap. It is significant that embarkation on a prototype venture called for an outlay of from 30 to 40 million dollars. Had any of the various bills that were introduced subsequently in Congress been enacted, it is only fair to say that they would not have been palatable to our industry. In most cases they would have set up intermediary Government groups between industry and the operators. They called for the establishment of corporations, heavily staffed supervisory bodies, control over patents and finances and profits, new procurement agencies, recapture clauses, and other features which would have operated to put our transport manufacturers in a strait jacket.

As late as January, 1950, the Department of Defense worked up a prototype program calling for appropriations to purchase prototypes of two cargo aircraft, one designed primarily for civil and one for military purposes. This program did not get far, for it was rejected by the Bureau of the Budget.

The next effort was the concept of the Air Coordinating Committee, which sponsored a bill that would authorize appropriations to the CAA enabling that agency to pay for the flight testing and other costs associated with transport certification. Our industry supported this particular bill, and it was ultimately passed as Public Law 867. No implementing funds, however, were ever provided, and I feel that this was unfortunate, for the engineering representatives of the CAA, CAB, Air Force, Navy, NACA, air lines, and manufacturers had collectively and painstakingly developed a flight-test program to accumulate much needed design and operational data.

Public Law 867 will be "on the books" until September, 1955, and there is some possibility that it might yet be utilized by our manufacturers in the flight testing and accelerated service testing required for airworthiness certification of their recently announced jet-transport designs.

Admiral Horne has worked up a testing program involving an outlay of about 1.6 million dollars and has submitted this to the Bureau of the Budget, where, I understand, it has not received a favorable reception. It was hoped that it might go through as a supplemental 1953 appropriation, but prospects apparently are not bright. This relatively modest sum would provide for the testing of the Canadian Avro, the Allison Turboliner, the Douglas F3D, and perhaps later the A3D, if the Navy were agreeable to allocating one of these planes for such a purpose. Through the program devised, it is felt that whole or partial solutions to many unsolved questions of primary interest to the Air Transport Association would be reached. I hope, therefore, that we be not reconciled to defeat and that continuing effort be made to push this project through.

To continue the history of prototype legislation, Senator McCarran next introduced a bill, known as the McCarran Differential Subsidy Bill, patterned after the Merchant Marine philosophy. This also failed of enactment.

At one time, the Navy had on the books a restriction, imposed by Congress, that 10 per cent of our aircraft and aircraft engines would have to be built at the Naval Aircraft Factory, with the end in view of establishing a yardstick of costs so that we would not be held up by private enterprise engaged in the manufacture of similar products. I have been Head of the Plans Division of the Bureau of Aeronautics and Assistant Chief and Chief of Bureau, and I regret that I have been unable to find out as yet how much it really costs to do anything at the Naval Aircraft Factory.

To bring ourselves up to date, I must now refer to Senator Johnson's bill, introduced in the last session of the 82nd Congress, which would permit Government loans through the Department of Commerce of up to 15 million dollars to any qualified company wishing to undertake the development and construction of a jet-transport prototype. The most interesting features of this measure are that the loan would be made on the basis of 1 per cent annual interest, that for every transport sold the debt would be reduced by 1 million dollars, and that the certification costs also would be defrayed by the Government. Mr. Hinshaw has introduced a companion measure in the House.

I have discussed this bill with our company heads, and I feel that I can state an industry position on its provisions if and when hearings are held during the present Congressional session.

The CAA Prototype Survey team that visited various European countries in mid-1951 reported that in overall turbine-engine development, Great Britain and the United States appear to be on a comparable basis except for production techniques, where we hold an advantage.

Presented at the Washington, D.C., Section, IAS, February 3, 1953.

* President.

Optimum utilization of the turboprop engine appears, at present, to lie in two definite spheres of operation. First, short-haul operations of distances between 250 and 700 miles, where the greater proportional time spent on the ground in run-up, taxiing, climbing, holding at approaches, and efficiency in take-off and climb at lower altitudes, etc., favor the turboprop. Present turbojets, for example, travel about 300 miles by the time cruising altitude is reached. Turboprops are also efficient for long-range operations, particularly cargo hauls, where greater weight-carrying potential rather than high speed is important and fuel consumption soon becomes the governing factor.

Now let me list a few of the major operating problems that we foresee in the jet-transport field. These are:

(a) Air traffic control and navigational problems such as approach procedures, stacking, and separation.

(b) Problems arising from flush or submerged antennas.

(c) Need for collision and thunderstorm-avoidance radar equipment.

(d) Fuel reserves to cope with engine failure and possible resultant forced operation at lower altitudes to destination or alternate.

(e) Fire hazards resulting from high engine temperatures and high rates of fuel flow.

(f) Precautions against decompression failures of the fuselage.

(g) Landing deceleration of turbojet airplanes, particularly on wet or icy runways.

(h) High initial drag in event of engine failure in turboprop designs.

(i) Increased noise problems, particularly if JATO or take-off afterburners are used.

(j) Precautions against clear-air gusts.

Regarding airport problems in general, every effort is being made by the manufacturers to fit their new designs to the existing pattern of airport runway maximum lengths, widths, and strengths established by the CAA in administering the Federal Airport Aid Funds. This calls for maximum lengths of 5,900 ft. for continental service, 7,000 ft. for intercontinental service, and 8,400 ft. for intercontinental express service. These are standard temperature, sea-level conditions, and runway lengths are increased 7 per cent for each 1,000-ft. increase in airport elevation and $\frac{1}{2}$ per cent for each degree that the airport mean temperature exceeds the standard temperature.

Turbine-powered transports will all have ample power for take-off conditions, which means that landing distances will be the governing factor in establishing field lengths. Deceleration in landing is no problem for turboprops, but braking and stopping jet aircraft, particularly on wet or icy runways, is a real problem. Engine manufacturers are working intensively on developments to reduce the thrust existing during approach which results from the need to keep the turbines operating at sufficiently high r.p.m. to permit "go-around" in event of an abortive landing. Variable orifices at the jet outlet will provide reduced thrust while still operating the turbine at the same required minimum r.p.m.; however, cruising thrust is also reduced several per cent.

There is reluctance to accept the use of the landing chute as a means of deceleration on *every* landing in commercial operations. Arresting gear is another device, however, which may have promise. In any event, a great deal of development is needed to provide a sound solution to the landing deceleration problem.

Despite all the difficulties and hurdles we must surmount before we see American-built jet transports flying the airways, we obviously must get on with industry's part of the job, for we cannot easily recapture time that the British have gained. I am sure you would be interested to know of the detailed plans our major companies have for coping with the jet-transport problem, but this information is not available to me, nor, for good reason, would I want it to be at the present time. There have been general disclosures to the public which indicate accelerated interest on the part of our companies in a jet-transport project, and one of them, Boeing, has announced that it will have a plane of this type ready for display in 1954. Similarly, it is no secret that air-line personnel have been in close touch with Douglas, Lockheed, Boeing, and other companies of our industry, and the ATA has issued a set of design recommendations for turbine-powered transports. In this connection, reports indicate that the Douglas DC-8 will cost approximately $2,800,000, that it will cruise at 560 m.p.h. at 40,000 ft., and accommodate 90 first-class passangers.

I have mentioned earlier the reasons why our industry has been most reluctant to take the step into "subsidization" and a loss, partial or otherwise, of our competitive system in commercial aircraft development. Another important reason is the opinion expressed best by one member company, which I will quote:

"We would not have been able to start the design of a jet transport before now regardless of how many millions of dollars might have been made available by the Government. There has been one controlling factor all along which has prevented our going ahead regardless of other factors. That is the question of engines. We would not wish to bring out a jet transport the cost of operation of which was higher than contemporary piston-type transports. What we have had to do has been to watch the engine picture very carefully and time our actions accordingly. This has now reached the point where it is logical for us to go ahead in an orderly fashion with the design of a jet transport because, if we assume that nothing in the international situation or elsewhere interferes with the orderly progress of the work, it will take about the same amount of time to reach the prototype stage as it will take to get the engines. We could not have done it sooner, and we are not going to delay it regardless of the absence of Government assistance."

This philosophy appeals to me as being basically sound.

In closing, I feel that it is of the utmost importance to invite attention to the noise problem. This remains, as I see it, as the most difficult barrier we have to surmount in bringing our plans for the development and operation of jet transports to fruition.

The possible technical improvements in jet aircraft performance and structural strength are, unfortunately, not accompanied by ready solutions for reducing the noise level. In my opinion the "public on the ground" will never become reconciled to the relatively high noise levels generated close aboard by aircraft, and we can expect continued public resistance and indignation unless remedial measures are found.

The importance of the noise dilemma is reflected in a partial enumeration of the following activities in this field:

(a) The National Aviation Noise Reduction Committee, organized by the CAA with broad representation from Federal, state, and municipal governments, operators, pilots, and manufacturers, has a four-point program aimed at operations, research and design, airport location, and public relations.

(b) The NACA has recently established a subcommittee to investigate the fundamental sources of jet noise.

(c) The Research and Development Board has formed a panel to deal not only with noise from aircraft but also with that from all other types of military equipment as well.

(d) Air Force efforts have been principally in the field of muffling test cells and jet aircraft on the ground.

(e) The Office of Naval Research and the Air Force Aero Medical Laboratory have been studying the physiological effects of jet noise.

(f) The President's Airport Commission (Doolittle Commission) has studied and made specific recommendations on the noise problem in its report "The Airport and Its Neighbors."

(g) The National Air Transport Coordinating Committee (referred to also as the Rickenbacker Committee) has and is continuing to focus attention on the noise problem of aircraft in the New York area.

(h) The Airline Pilots Association is making sound measurements at critical locations in the United States.

(i) The Aircraft Industries Association's Noise Control Committee, which I believe was the first such committee established, has developed and issued a report on standards on noise measurement which are now in fairly wide usage.

The seriousness of the noise problem and our collective ability or inability to find a solution will certainly be a vital factor in determining the rate of progress of jet-transport development. It deserves all the ingenuity we can muster.

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Air-Line Point of View on

Status of the Turbine-Powered Transport in the United States

Milton W. Arnold*

Air Transport Association of America, Inc.

SEVERAL YEARS AGO, when the de Havilland Comet was still in the testing stage, a top United States air-line official sent out his personal Christmas card. It bore a reproduction of the Old North Church in Boston, from which Paul Revere received his famous warning, and the simple legend: "The British Are Coming!"

That was 1950. This is 1953; the British have arrived—jet propelled—and the race for air supremacy is on.

To trace the development of the Comet to its present scheduled commercial operations between London and Johannesburg would not be appropriate here. The pertinent fact is that the British have such a turbine-powered aircraft in scheduled operation and we have not.

The progress to date toward developing a jet transport suitable for the United States air lines has been almost entirely potential. With the exception of the Convair-Allison Turboliner, virtually no testing has been done in the United States on civil turbine-powered aircraft. Basically a Convair 240, the Turboliner is fitted with turboprop power plants, instead of piston engines. As the first step toward a United States turboprop transport, it made its inital flight in December of 1950 and is currently being flight-tested.

Just where do the air lines stand on the subject of the turbine-powered commerical transport plane at the present time?

(1) It is understood that Pan American Airways has ordered three, and taken an option on seven, of the de Havilland Series III Comet, scheduled for delivery in 1956. Though this purchase may have some influence on the actions of competitive operators in the international field, it is not likely that United States domestic carriers will be prompted to buy British jets.

(2) For some time the air lines have been in close touch with the aircraft manufacturers and have issued specifications for what they believe would be the most suitable turbine-powered aircraft. In other words, when it is time to introduce jet transports into the nation's airways system, both the manufacturers and the carriers will be ready to go.

Presented at the Washington, D.C., Section, IAS, February 3, 1953.

* Vice-President—Operations and Engineering.

For example, when asked recently if American aircraft builders could catch up with the British, the President of one of our most important aircraft manufacturing concerns replied as follows:

"You may rest assured that we have not been asleep at the throttle. Our company has spent a lot of time and money on this [jet] project and is making most satisfactory progress in the field.

"American-built air transports today dominate the world because we have always produced airplanes that can produce profits for their owners. When we . . . are ready to deliver jet transports, they will be able to make money as well as headlines. Our air-line operators prefer a few lines of small type in the income columns of the financial page to just big type on the front page.

"When our jet liners zoom into the skies—and that should not be too far away—they will fly at speeds of more than 560 m.p.h., carry in excess of 60 passengers, and be capable of crossing the United States in 4 hours, or of flying across any ocean or continent nonstop."

(3) The pioneering of the military in turbine-powered aircraft is of considerable value in projecting a jet-transport prototype. Though it is as unlikely as it would be unwise to base the development of a jet transport on military jet aircraft, much can be learned from studying the jet operations of the military.

(4) The United States has the greatest aerodynamic, structural, and production knowledge and experience in the world. This is borne out by the fact that about 80 per cent of the world's transport planes are American-built. Hence, when the United States turbine-powered aircraft presently in the design stage are ready to go into production, this knowledge and experience should produce aircraft superior to those now flying in foreign countries—provided, of course, that a testing program can be initiated to aid in reaching the proper design solutions prior to production.

The question is often raised: When American production begins to flow—somewhere around 1958—where will Britain be then?

Naturally, she would like to have jet prototypes ahead of America's though British authorities are not willing to bet on that. And they admit that big production will certainly be in American hands.

However, before the air lines can incorporate turbine-powered aircraft into their fleet, there are certain characteristics that a jet transport must achieve:

The Convair-Turboliner, America's first turboprop transport, is shown here during taxi tests in San Diego, Calif. Built by Consolidated Vultee Aircraft Corporation for the Allison Division of General Motors Corporation, the Turboliner is a research transport purchased by Allison to test its turboprop engines in a modern commercial-type plane. Two 2,750-hp. Allison 501 turboprop engines are installed in the Turboliner. The plane is a modified 40-passenger, twin-engined Convair-Liner commercial transport, fleets of which are widely used by domestic and foreign air lines. The Turboliner made its first flight on December 29, 1950.

(1) First and foremost, it must show no backward step in safety; it is hoped that it will show a substantial improvement. We recognize, of course, that the control of the aircraft for landing and take-off must be equal to, or better than, the present-type transport. A serious problem is that of deceleration, and at the present time there appears to be no particular answer to the problem. By that we mean that the use of parachutes and the present development of reversing JATO is not a satisfactory answer in its present form of development. Also, there is the serious limitation of the present jet in its operation on slick or icy runways. Here, we must depend entirely upon the use of brakes as a means of control. With the gas-turbine engine, it is not nearly as satisfactory from a control standpoint as a transport without reversing propellers, and, certainly, reversing propellers give added control under these conditions. Consequently, from a safety standpoint, we cannot afford to go backward.

(2) The air lines would like to see developed one basic type of turbine-powered airplane capable of carrying from 70 to 80 passengers and of fulfilling major requirements for both transcontinental and international service. The maximum range hoped for would be a transcontinental and transatlantic nonstop operation, the minimum range being about 500 miles. However, if penalties are excessive for either service in order to perform economically the other service, consideration should be given to providing such features as alternate wing panels, increased structural strength, additional fuel capacity, etc., in order to build one basic type of aircraft to serve both markets. In view of the air lines' collective route requirements, it is desirable for the airplane to have the widest possible useful range.

(3) The real problem for the air lines is to acquire a turbine-powered plane whose total direct operation cost per ton-mile is equal to or less than the operation cost of current transport aircraft. The jet engine developed to date consumes so much fuel that it is impossible for an airplane thus equipped to operate profitably. And though the high rate of fuel consumption is a significant cost factor in itself, even a greater contribution to operating costs is the fact that such a high proportion of the plane's carrying capacity must be devoted to transporting fuel rather than to carrying revenue-producing passengers, mail, and cargo.

A good index of relative fuel economy is the fact that the DC-6B consumes 8.9 lb. of fuel per mile. The jet aircraft of about the same size, despite its much greater speed, will require about 20.4 lbs. of fuel per mile.

(4) Though fuel consumption is the principal element of increased jet operating expense at the present time, there are other elements. The jet engine to date is not as reliable as the reciprocating engine. It will require more frequent periods of overhaul, and its total operating life will be shorter. Its initial capital cost may be five to ten times the cost of the reciprocating engine; its cost per hour of total life operation may be 10 to 20 times greater than the present cost of reciprocating engines, depending upon how long the jet engine will last in operation. And we do not know that yet.

It has been estimated that it will cost about $30,000,000 to develop a United States jet transport proto-

type. Production models cast from the prototype may cost in the neighborhood of $2,000,000–$4,000,000 each, depending on size and quantity produced. Present four-engined transport aircraft cost about $1,000,–000 to $1,700,000 apiece.

In a word, then, cost has been the main obstacle in the production of a turbine-powered aircraft in this country. Since United States air lines are privately owned, they must be self-supporting and also must operate with profit. This is basic to our conception of private enterprise. The British seem presently willing to lose money in the operation of jet transports partially as a continuation of their pioneering program and partially to bring prestige to British products. The British Government foots the bill.

In the United States, air transportation is a commodity. The job of the air lines is to sell this commodity to the public.

To sell our product (we cannot give it away), its price must be competitive with other forms of transportation. Fares must be low enough to encourage an increasing number of people each year to travel by air.

On the basis of present estimates of cost, we cannot operate jet transports and break even at present fare levels. There are a limited number of people who would be willing to pay higher fares to go 600 m.p.h. rather than 300 m.p.h. But there are not enough of them to make a business of it. The average traveler does not want to pay more, and he is reasonably content with speeds of 300 m.p.h. at the present price. He would prefer greater speeds but only if they can be provided with little or no premium over the present price.

As a quick rule of thumb, the present Comet cost of operation per airplane mile is slightly in excess of the airplane-mile cost of operating a DC-6 or Constellation. Yet on comparable runs the Comet is seating between 35 and 42, compared to 55–65 in the Constellation and DC-6. Hence, from a revenue standpoint, we would be operating an airplane whose per-mile cost is approximately 100 per cent greater.

If we need to raise the price of air transportation to break even on the cost of operating a jet transport, we would lose most of the "average" customers; and, if we lose that group, we lose the ability to produce, and sell, large quantities of air transportation.

It all reduces to this: There will be reasonable opportunity for the jet machine when it can operate as economically per passenger-mile, or per ton-mile, as the present type of airplane. There will be great opportunity for it when its relatively high speed can provide a substantial reduction in operating cost per passenger mile and per ton-mile. Since each new airplane type has been faster than its predecessor, we have expected operating economies from the increased speed; and we have always had them. That is the principal reason we can sell air transportation in 1952 with so little increase in price over 1940, in spite of higher costs for all purchases. But, as yet, the jet machine demands a higher unit operating cost, not a lower one. There will be no widespread demand for the jet transport, as a productive machine, until the trend is reversed.

Preliminary model of Pan American World Airways' version of the de Havilland Comet III jet air liner powered by four Rolls-Royce Avon R.A.16 axial-flow turbojet engines. Pan American has ordered three, with deliveries to begin in 1956.

To summarize: There are no inherent mysteries about jet airplanes. Several have been built, and it would be easy enough to build a better one without delay. The basic problem is that no one has yet been able to build a turbine-powered aircraft that can pay its own way. Though the air lines are fully cognizant of the longer-range possibilities of jet power, it is not economically sound for them to make large capital investments in jet transports at the present stage of their development.

Practically no scheduled operations of turbine-powered aircraft have been undertaken to date by either the military or commercial operators. Until greater actual operating experience is obtained, it would be optimistic to imagine that all operating problems have been anticipated or that presently contemplated solutions to the anticipated problems will be correct, for this reason, it is of utmost importance that the manufacturers constantly survey experience obtained with turbine-powered aircraft through the development period of this airplane. Particular consideration should be given to lessons learned from such experiments as BOAC's operation of the de Havilland Comet, CAA's plan (if materialized) for developmental flight testing of jet-type aircraft, and the CAA and NACA research program aimed at establishing the best operating and design criteria for jet aircraft.

In this way, the turbine-powered transport aircraft, when developed, will represent not only the greatest possible research effort but also lessons learned from experience.

Lockhead C-130, prototypes of which are now under construction, is America's first turboprop transport designed as such and scheduled for production.

MATS and the Gas-Turbine Transport Field

LT. GEN. JOSEPH SMITH, USAF*

Military Air Transport Service

THE DEVELOPMENT AND PRODUCTION of large transport-type aircraft, whether military or civil, has entered into a new era. Economics of development and production have dictated the era. With each year, the era assumes greater importance. . . . I believe it is sound and necessary for the United States Air Force to bring gas-turbine-powered transport aircraft into the military service to keep our transport fleet abreast of the technological advancement in aviation.

Presented at the Washington, D.C., Section, IAS, February 3, 1953.

* Commander.

Already, the USAF has contributed considerably in this direction—although not directly on transports. We have had many jet fighters and bombers in operation for some time. As a result we have accumulated thousands of hours of experience. This experience has proved that invaluable and progressive improvements can be anticipated for the military and the civil carriers.

The gains made over the years in the development of the gas-turbine power plant can and will be made directly applicable to our gas-turbine-powered transports of the future.

Both the U.S. Navy and USAF are strongly supporting turboprop development in the R7V, R3Y, C-130.

T-29, and the C-124. The USAF has awarded contracts to several of the aircraft manufacturers to make exhaustive studies of the various types of gas-turbine-powered transports which can best be configured with the engines available in the next 5 to 10 years.

These studies are now being received and studied. After our complete evaluation, we shall be in a positive position to suggest what direction the development should take and support it accordingly.

I feel that all of these projects have directly supported and accelerated the development of gas-turbine-powered transport aircraft.

From the military point of view, I believe that the turboprop transport will be used on long-range cargo operations and that it has a definite place in our service. I believe, also, that it has a place in the commercial cargo operation. For instance, the C-130, with its large cargo compartment, truck-bed height loading, and many other features strictly designed to enhance cargo carrying, lends itself to optimum operation in the transport of heavy and bulky loads.

On the other hand, the straight jet transport with its considerably higher speeds and more habitable features will not be required to carry this type cargo. The jet transport is ideally suited to the mission of rapid transportation of high priority passengers, patients, and air express to and from overseas areas. I believe the most critical cargo that we shall be called upon to transport with rapidity in any future emergency will be personnel, scarce and expensive materiel, whole blood, and other critical medical supplies.

At this point, I should like to reiterate the view that I have expressed at every opportunity: One of the most important types of cargo which we or any air carrier will haul in war is people, and to conserve scarce and skilled personnel the pipeline time must be reduced to a minimum. The jet transport is best suited to accomplish this task.

A review and comparison of MATS requirements and characteristics for the jet transport and those of the commercial long-range carriers operating outside the United States will indicate that we are not too far from complete agreement.

At the present time, there appears to be quite naturally some divergence in the requirements of the military and the civil carriers, concerning cargo carrying. The divergence applies to both reciprocating and turboprop transports.

However, this apparently does not apply to future jet transports. There appears to be no reason why the military and the civilian carriers cannot get together and come up with a parallel set of characteristics and requirements which will make possible the early availability of suitable low-cost jet transports to both. Certainly, in both cases, plans for the use of this airplane are similar enough to permit complete cooperation in arriving at a final and satisfactory solution. In MATS, we see no reason why the military and civilian requirements for a jet transport cannot be quite comparable—as they should be—to obtain best results.

Moreover, there is a critical need for the provision of the maximum of interchangeability between the civil and the military carriers to provide for the optimum utility of the combined fleets in the event of any emergency.

Equally important is the fact that, as the military necessity for these diminishes and expansion of the commercial fleet is required, military aircraft can be readily pressed into a commercial operation. This was done somewhat effectively immediately after World War II.

The British today are getting much experience in the operation of the various Comet series. By drawing on that experience we can keep abreast of the problems that this new phase of air transportation is presenting.

Certainly the Comet of today cannot be considered as the economic transport against which we must compete. Low ton-mile costs should be available in our first and continuous effort. We, in MATS, as well as those in commerce, believe we should not allow ourselves to be drawn into a development that is uneconomical.

Since the United States manufacturers have now actively taken up the gas-turbine transport development with no direct aid from the Government, we feel that MATS might well participate in proving the prototypes.

Testing of new equipment and/or systems is provided for in the MATS charter, and, if MATS were permitted to do the testing, it would relieve the air lines and the manufacturers of a heavy burden. Certain developments within the military which are directly applicable to jet operation, yet not available immediately to commercial operators, would greatly enhance this program.

It appears that we are well on our way to solving the problem of making the jet transport airplane a real thing. However, I do not believe that many of us realize that perhaps we are not as ready for the jet transport as it is ready for us. The military services have not had experience in a steady day-to-day, hour-to-hour, jet-type operation that is required of scheduled transport. So far, we in the USAF have been fortunate enough to be able to tailor our jet flights to suit the weather and other factors. An air transportation system is comprised of aircraft, airfields, and adequate weather and communications support; navigation and air traffic control facilities; foolproof maintenance standards and procedures; a sound logistics system; rules and regulations; and, above all, plenty of horse sense.

For instance, let us take just one single phase—weather requirements. Let us examine a few of the problems in detail. The phenomenal speeds and heights which jet aircraft are capable of attaining are common knowledge. But not everyone appreciates the peculiar performance characteristics that render the jet-propelled aircraft of today less able to cope with certain conditions in the atmosphere than propeller-driven aircraft. Even fewer people realize how these

This is the Convair XP5Y-1 super seaplane, world's first turboprop flying boat, shown soaring above San Diego on maiden flight.

characteristics introduce requirements for weather service and information unheard of heretofore.

The range of a fully loaded jet aircraft is greatly increased with the percentage of time that can be spent at high altitudes. For example, when a jet attains maximum range by leveling off at 35,000 ft., only 57 per cent of this range is accomplished by leveling off at 15,000 ft. A jet loaded for a range of 4,000 miles under most efficient flying conditions reduces its range to about 1,000 miles by climbing to 35,000 ft., descending to sea level, and again climbing to 35,000 ft. The rate of fuel consumption at sea level is at least three, and can be as much as ten, times as great as that at 35,000 ft.

The optimum flight altitude for jet aircraft is in the general vicinity of the tropopause where winds are characteristically strong. For this reason, wind becomes an important factor in planning for a flight. A jet can depart a few thousand feet from optimum altitude to gain the advantage of a favorable wind or to minimize the disadvantage of an unfavorable one. However, extreme departures can so reduce engine efficiency that a careful computation must be made to obtain maximum range from a combination of wind and altitude factors. The jet pilot cannot afford to wander up and down in search of the most favorable wind. He must know at what altitude to find it before he takes off. Jet streams, which are concentrated bands of winds frequently in excess of 100 knots, can be either a great help or a great hindrance. In either event, their heights and paths must be known.

The higher the temperature, the lower the efficiency of the jet-propelled aircraft. The range of a typical jet will be reduced by about 8 per cent of that computed in the flight plan if the air temperatures at cruising altitudes turn out to be 10°C. warmer than expected.

Forecasting of upper air temperatures, therefore, assumes added importance with respect to fuel consumption and speed in climb. The rate of climb of a certain model jet decreases 63 ft. per min. for each air temperature increase of 1°C. at a constant power setting. In standard flight planning procedure, a pilot climbing from 35,000 to 40,000 ft. must plan to use 20 gal. of fuel if the temperature is −60°C. and 65 gal. (three times as much) if it is −48°C.

Equally important, temperature effects are experienced in the lowest levels of the atmosphere. The inferior performance of the jet in take-off is well known. The higher the temperature, the poorer this performance becomes. For example, with a 6,000-ft. runway and a runway temperature of 40°F., one jet aircraft can take off with a pay load of 2,200 lbs.; at 80°F. this load is reduced to 700 lbs.; and at 95°F., it is reduced to zero. Unfortunately, the temperature over a concrete runway is frequently several degrees higher than that in the free air which our thermometer mounts are designed to measure. As a result, we are already called upon to make special runway temperature observations at jet bases on clear, calm summer days so that safe take-off loadings may be computed. Mechanical aids such as JATO are used on such days and these in turn require a special forecast so that take-offs are not delayed awaiting delivery of JATO bottles.

The need for accuracy in terminal and alternate forecast is stressed by jet pilots because of the low operating efficiencies and excessive rates of fuel consumption in climb. Once a pilot has begun his descent from cruising altitude, he has committed himself to landing at that terminal. When unexpected terminal weather develops, it is mandatory that the information be radioed to the pilot while he is still at cruising altitude so that he may divert to an alternate before beginning his descent. This is the reason we had to go to direct pilot-to-forecaster radio at many jet terminals.

These are just *some* of the problems in providing weather requirements alone. There are even more problems associated with air traffic, navigation, communications, etc. All these requirements must be tailored to meet the new situations presented by the change-over to *jet operations*. The planning in these fields must proceed right along with the development of the transport aircraft, and we must anticipate all requirements and arrive at their solution.

In summarizing, I should like to stress the main point of this discussion—that is, we must all think in terms of a jet transportation *system* and not just of obtaining a jet transport.

The success of jet transportation lies in the solution (concurrent with the development of the jet transport aircraft) of the problems associated with the factors that go to make up the jet air transportation *system*.

Aircraft Approach Tolerances

Pilot Problems in the Last 3 Min. of a Successful All-Weather Approach and Landing

ARTHUR E. JENKS*
Civil Aeronautics Administration

THE PROBLEM OF ALIGNING AND POSITIONING an airplane as a prelude to the safe utilization of the touch-down area of a runway, in weather, might be considered "old hat" by a few people. Some experts take the attitude, "Sure, we know what the problem is; as soon as we have this device or that gadget the problem is solved." It would be natural to assume that with all of our modern know-how and improved radio aids, instrumentation, and communications we would, at least, have the approach problem solved. Even though we cannot make consistent blind landings, the fact is we *still* miss approaches. We are flying tougher weather in some aspects than heretofore, but, on the other hand, the performance, weight, and procedures have also complicated matters. There was a time when a second pilot was needed in transport aircraft as a safety factor. Now, the second man has a full-time job, and in our four-engined aircraft we have a third member in the cockpit, the flight engineer. One pilot is flying the airplane; the other is monitoring the instruments, power settings as called for, landing gear and flap configurations, cabin pressurization, and, at the same time, acting as an aerial switchboard operator handling communications. Due consideration must be given to the demands on both men and machine in this portion of the flight which is the pay-off of aerial transportation. If you cannot arrive at the point you started for *safely*, the flight cannot be considered a success.

APPROACH INSTRUMENTS

Let us look at the instruments used in modern flying to achieve approach success such as (1) basic flight instruments, which give attitude, heading, and air speed and (2) radio guidance instruments, which can be broken down into the following:

(a) A very narrow VHF localizer beam that furnishes runway alignment.

(b) A still narrower UHF glide-path beam that furnishes the hill or slope terminating at the end of the runway.

(c) A 75-mc. outer marker beacon along the route which identifies the start of the glide slope at the final approach altitude and a middle marker that is approximately 3,500 ft. from the end of the runway. These markers furnish a blinking light indication simultaneously with a tone in the earphones, thereby indicating position fixes as their respective radiation patterns are traversed.

(d) We supplement the 75-mc. markers with low-powered, nondirectional facilities at one or both marker locations which give us an ADF bearing at that point, and, in addition, the ADF reversal upon crossing the transmitter is a secondary confirmation of position fixing.

(e) Airport surveillance and precision radar can be used as a primary approach system, or both ILS and radar can be used together, one monitoring the other.

The instrumentation of both ILS and GCA furnish what we call "amount" information. They tell us the amount we are displaced at the precise instant, and experienced GCA controllers can usually anticipate the correction and instruct the airplane accordingly. This, however, has its limitations. Similarly, on ILS a given amount of displacement can be corrected nicely in certain parts of the approach, but in other areas, particularly in close, the same amount of indicated displacement presents a different problem. In both types of approaches, we are endeavoring to achieve straight-line flight, and any experienced pilot can readily verify that flying a straight line is extremely difficult, particularly a predetermined straight line, and not merely a matter of holding a heading. Several types of computers have been built which have increased the overall success of approaches, and the primary function of the computer is to anticipate the correction required and furnish this information either to the pilot, in an easy and understandable form so that the desired correction is achieved, or directly to the autopilot.

FLIGHT CHARACTERISTICS OF STRAIGHT-LINE FLIGHT

Of great importance and yet least understood by pilots in general are the flight characteristics of an airplane in straight-line flight. Straight-line flight involves a steady hand and head at the controls and consistently means the employment of minute corrective turns because, to fly a straight path, the plane is constantly varying from one side to another, and it is only by instantly and carefully correcting these vagaries as

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* Chief, Flight Inspection Division, Federal Airways.

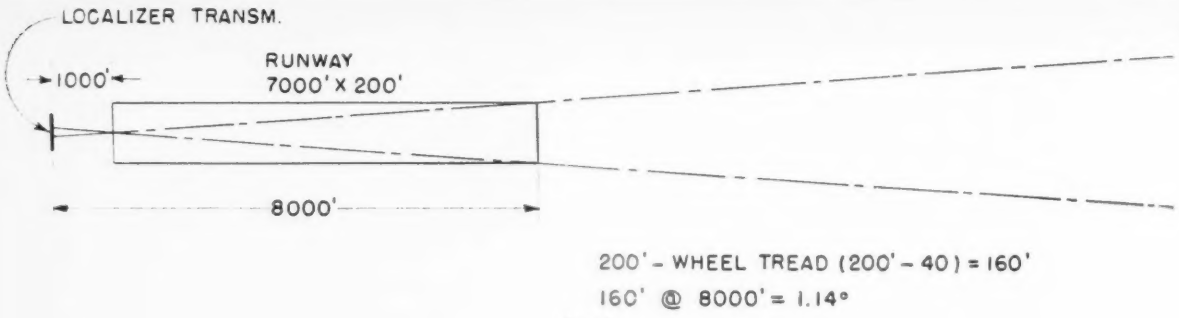

FIG. 1.

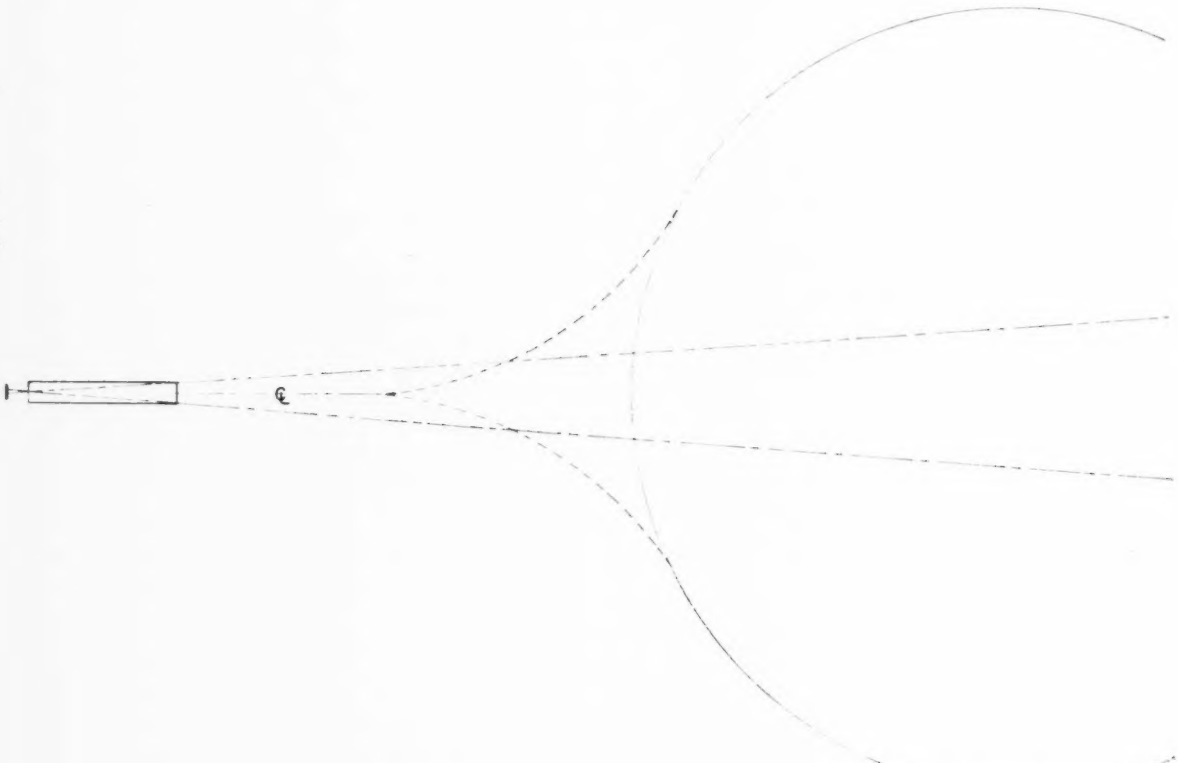

FIG. 2.

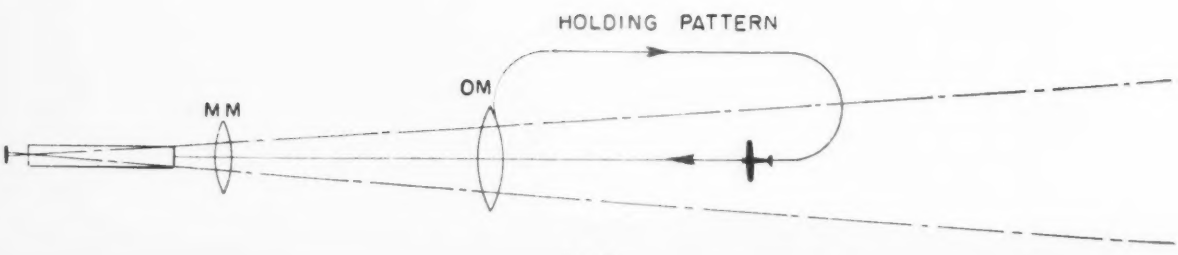

FIG. 3.

they occur that straight-line flight can be achieved. To accomplish this on a visual approach is comparatively easy because in that type of approach you can see where you are going, and it is possible to practically "gun-sight" the aircraft if precision alignment is required. To do this on instruments, with all of the "assists" from radio aids, means that there is a much more complicated problem. We can no longer "gun-sight" the airplane, and our intelligence is restricted to an indication of displacement, or, if we have a computer or a good GCA controller, this anticipatory information will get us back in the groove, but the correction cycle starts all over again if we cannot maintain the groove once it has been achieved.

An examination of the actual physical airspace tolerances that are required will show that our basic problem is a stabilized flight path on a ground track that is within $\pm 1/2°$ of the runway centerline (Fig. 1). The stabilized requirement is only peculiar to precision approaches at low minimums. An example of what is possible were the instrument restriction removed is shown in Fig. 2.

Fig. 3 is a sketch of what we are actually trying to accomplish—i.e., straight-line flight within $\pm 1/2°$ of the runway centerline extended, starting beyond the outer marker. An indicated displacement of three needle widths on the deviation indicator is representative of an actual displacement of approximately 500 ft. from the centerline at a distance of 7 miles from the end of the runway, whereas the same amount of indicated displacement means only 184 ft. of displacement when $1 1/2$ miles out.

Turn Correction in Instrument Approach

Now for a brief look at the type of turn a pilot uses for correcting these displacements on an instrument approach. On an average, most pilots use a 1° per sec. turn, which can be interpreted as a bank of 5°–9°. On most "T" category aircraft, a bank of more than 16°–18° places the wing tip lower than the landing gear (in the extended position), and pilots are quite conscious of this, particularly in the lower portion of an approach. The majority of corrections are made with the 1° per sec. turn, but the *amount* of turn will vary. A pilot may use a heading bracket of ±10° at the start of an approach but tries to reduce the bracket to ±3° as rapidly as possible. This could be considered good practice until all the complexities that effect straight-line flight are examined. Some of the more serious and unpredictable are: turbulence, gradient windshift, the quality and accuracy of heading information in the cockpit, and the quality of the reference alignment—e.g., bends or "scallops" on the ILS beam or GCA asking for a maneuver that the pilot considers too wild at that stage of the approach.

Studies and Reports

Now to digress a bit. Recently during the CAA-sponsored Approach Light Evaluation Program, wherein pilots were asked to comment on the various light configurations after actual approaches on same, several highly analytical reports were received covering incidents of misalignment in extremely poor visibility on left-hand row configurations. The gist of these reports was that, in poor visibility, the misalignment was not detected until the threshold of the runway was in view at approximately 1,500–1,700 ft. out. The resulting correction of 75–100 ft. of displacement, plus the heading difference, consumed the remaining distance on the approach lights and also 1,500 to 2,000 ft. of runway before alignment and attitude were stabilized for landing. These incidents involved aircraft with landing weight wing loadings of from 45–55 lbs. per sq.ft.

After studying these reports, the incidents were duplicated in a DC-3 and photographed under VFR conditions. The results verified the pilot reports, allowing for the difference in wing loadings.

Our next contact with this factor of turn correction vs. distance occurred while completing some work on auto-approach-coupler performance for Radio Technical Committee for Aeronautics, Special Committee 18, wherein controlled amounts of ILS beam discrepancy were fed into the coupler, and the resulting correction was meticulously followed from both a track and a heading study.

One of the results of this study was that the aircraft heading started to change within a fraction of a second following the application of the turn, but the aircraft track continued on, with no measurable departure therefrom for 1,200–1,900 ft. over a groundspeed range of from 129–171 m.p.h. A recheck of the instrumentation employed showed that any possible lag due to instrumentation or polarization effect could only account for 0.8 sec. at the maximum. Therefore, it could be assumed that the aircraft needed from $4 1/2$–7 sec. (depending upon the initial bank employed) to show a measurable departure from track after the turn had been initiated. All of these turns were made by autopilot, so that there was no human factor of dissimilarity to be considered.

Our next reference is a research memorandum published by NACA entitled *A Comparison of Effectiveness of Coordinated Turns and Level Sideslips for Correcting Lateral Displacement During Landing Approaches* by Stanley Faber. The results of this work are summarized in the report as, "For all distances from the end of the runway, coordinated turns are the most effective maneuver. At distances of less than 1,300 ft., the amount of correction is almost negligible for either maneuver." The particular aircraft under study in this report was a C-54D with a wing loading of 36.9 lbs., and the approach speed used in the work was 120 m.p.h. Whereas the conclusions arrived at in this report are partly from flight tests and partly from computation, the distance factor of 1,300 ft. comes close to the findings in the approach-coupler study, if allowance is made for the difference in wing loading.

Time Lag in Small Corrections

In resuming the discussion of the type of turn used in a precision approach, it is apparent that one of the more serious detriments to achieving straight-line flight is the fact that the aircraft does not respond to these minute turns or corrections at the instant of application. The aerodynamic forces may be applied for a corrective turn—namely, the coordination of bank, rudder, and elevator. Yet, the mass of the aircraft continues along a ballistic path until these forces become of sufficient quantity to deflect the mass in the desired direction. The time lag in response to small corrections appears to be a function of wing loading and ground speed, insofar as distance consumed before the turn becomes quantitative. This difference between the theoretical aerodynamic path of the aircraft and the actual ballistic path of the aircraft may be likened to the same effect that causes slip in the measurement of propeller efficiency. The turning forces are established when the airplane is banked, followed by appropriate coordination of rudder and elevator. The time for these forces to react in a slow-speed aircraft with a low wing loading is almost negligible, but, in high wing loadings and approach speeds in the 150 m.p.h. category, it becomes a factor that must be considered if we wish to improve our approach success.

For example, at $1^1/_2$ miles from the end of the runway, the pilot still on instruments observes that he is slightly off course, perhaps only two or three needle widths on his ILS deviation indicator. He applies a small correction, usually about a 5° turn. With a wing loading of 45 lbs. per sq.ft. and a ground speed of 135 m.p.h., the aircraft will just begin to deviate from the previous track after he has turned 5°. The airplane has progressed nearly 1,500 ft. before any measurable departure can be noted. Insofar as the pilot is concerned, he has turned 5°, and nothing has happened; so he adds a few degrees more to "pep things up," and it does! In the meantime, the aircraft's track is beginning to coincide with the aerodynamic track. Things begin to happen fast now, and the correction overshoots the desired alignment before the pilot can turn in the opposite direction. Until he has turned in the opposite direction some 3° or 4°, his flight path continues to become displaced on the opposite side. Finally, the second correction takes effect, and he has to turn the other way to stop it. All of this is an attempt to show how a flight path oscillation can develop which seriously disturbs the pilot's "tranquility of spirit." It produces instability and consumes precious time, particularly when the end of the runway is approaching at the rate of 200 ft. per sec.

Transition from Instrument to Visual Flight

With present-day minimums, at some point near the middle marker, the transition from instrument to visual flight occurs. This can be anything from something fairly abrupt to an operation that is quite gradual, lasting from 8 to 12 sec. The transition stage is from the point where the first light is identified to the point where the flight is entirely visual and can be continued to touch-down in that manner.

Now, if we summarize the situation at this point, it would be of this order: The pilot has done a routine precision let-down for the first 3 miles of his approach and has descended from 700 to 900 ft. below his starting altitude. It is becoming increasingly difficult to maintain straight-line flight because of the slight oscillatory condition that has developed, and while devoting his attention to dampening the oscillation and at the same time staying within alignment, lights become visible. He still cannot leave instruments to continue the flight visually until the lights are identified and a sufficient quantity (depending upon slant range visibility) is in view. If at this point on the approach he is passing through the critical altitude of his aircraft, the decision must be made then and there to either land or abort. This is a tremendous psychological responsibility for the pilot. The responsibility is his for a "snap decision" affecting the safety of his passengers and equipment. You cannot place a monetary value on this type decision. The pilot has no chance to mull it over or "table" it until tomorrow. In fact, he cannot choose his own time; approach control and the speed of his aircraft do that for him. Pilots such as our air-line captains are trained to stay ahead of every situation, to think well in advance of every probability. Yet, this is one instance where they have to take it as it comes, and only experience, proficiency, and "recency" are the things that count. We can ease this part of the pilot's problem if we can guarantee alignment, keep him "in the groove," and let him devote all of his attention to "go" or "no go" straight ahead, without superimposing the problem of "which side am I going to be on?"; "can I bend it around and get in?"; "am I off too far to make it?"; and "if I do make it, will I have enough runway left to stop on?"

Conclusions*

(1) A factual measurement of the turn/time lag should be made for each type of "T" category aircraft at the time of certification and the results placed in the operations manual. The measurement should be made at gross landing weight and should blanket the bank angles and approach speeds allowable.

(2) Precision approach paths, particularly the last 3 miles or final stabilizing zone, must be as straight as possible.

(3) Heading instrumentation in the cockpit should be improved. Lag or lead in a gyro repeater can seriously add to oscillation problems.

(4) Approach light lanes are not long enough. The light lane should be as long as the duration of the greatest allowable correction for the heaviest and fastest

* The conclusions are the author's personal opinion and not official CAA opinion.

aircraft; otherwise, the runway must be used for this purpose. The cost and availability of landing surface are critical; therefore, landing surfaces should be used for their intended purpose—i.e., the landing and take-off of aircraft. The provision of paved area *to fly over correcting aircraft alignment* is an expensive and inefficient operation.

(5) With the advent of DME or other suitable means of knowing position while on an approach, an appreciable improvement in pilot technique is in order, after procedural training.

(6) GCA controllers should be acquainted with the turn/time lag and allow for it in GCA precedures. At present, there appears to be a blanket policy of allowing 7 sec. for aircraft response. GCA personnel charge this to communications lag and pilot reaction time, when actually it is the aircraft itself which has the slow response.

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Summaries of Current Papers Accepted for IAS Publications

Stall Flutter in Cascades

By

Fernando Sisto

Wright Aeronautical Division, Curtiss-Wright Corporation

Assuming the complex of oscillatory aerodynamic reactions to be small compared to blade inertia and elastic forces, some results from nonlinear mechanics are utilized to develop a convenient method of studying stall-flutter oscillations. This represents a new approach to the problem.

Data are presented from an exploratory experimental investigation of a "two-dimensional" cascade in which one blade and, later, three blades are flexibly mounted. The variation of flutter amplitude with stream velocity and mean incidence is obtained for angles of attack near the static stall. Experimental determinations are given for three different gap chord ratios. The motion is predominantly torsional.

The results confirm certain deductions from the nonlinear theory concerning transient behavior and equilibrium flutter amplitudes, or "limit-cycles." Other qualitative results are reported which confirm the necessity of adopting this general approach in order to explain the important features of stall-flutter phenomena.

Preprint No. 402

A Method of Estimating the Compressive Strength of Optimum Sheet-Stiffener Panels for Arbitrary Material Properties, Skin Thickness, and Stiffener Shapes

By

W. R. Micks

The RAND Corporation

Developed in this paper is a simple analytical method of synthesizing allowable stress curves for optimum sheet-stiffener compression panels. This method may be used with any structural material and any stiffener shape. The only material properties required in the analysis may be determined from a compression stress-strain diagram for the material being used.

Also included in the analysis are the effects of varying the relative amounts of panel material allocated to the skin.

Analytical results are compared with the results of tests conducted by the NACA.

Similarity Theory of Isotropic Turbulence

By

J. C. Rotta

Max-Planck-Institut für Strömungsforschung

The basic idea of this representation is that an arbitrary homogeneous and isotropic turbulent motion tends, in the course of time, toward a universal state, in which all statistical properties are determined by only three magnitudes. From dimensional arguments a general law of similarity for isotropic turbulence can be formed. The equation for the corresponding energy spectrum is derived from the well-known equation for the change of spectrum and has a one-parametric set of solutions. But only one of these solutions is distinct, in that it satisfies the continuity condition in the range of the smallest wave numbers. This distinct solution can be considered as corresponding to the universal state.

Comparisons of the theory with measurements of turbulence produced by a uniform stream of fluid passing a mesh grid are discussed. According to this, it is at least probable that the universal state of homogeneous and isotropic turbulence is correctly described by the distinct solution of similarity.

A Steady-Flow Aeroelastic Study by Electrical Analogy

By

Robert H. Scanlan

Centre National des Recherches Scientifiques, France

The present paper describes the use of the electrical tank "lifting surface calculator" of Malavard and Duquenne in France for an aeroelastic study. The new items brought out here are: (1) the applicability of this electrical analogy to the calculation of certain "elementary" aerodynamic effects, in incompressible flow, which are of considerable utility; (2) the specialization of structural influence coefficient concepts, permitted by the availability of the new means of aerodynamic calculation, which allow the calculator to avoid oversimplified notions such as that of an elastic axis and of the rigidity of the lifting surface in the wind or flight direction.

With the analogy in mind, suggestions are also made for subsonic compressible flow aeroelastic lift distribution studies and for accounting for large dihedral effects on incompressible flow distributions.

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Subsonic Compressibility Corrections for Propellers and Helicopter Rotors

By

E. V. Laitone and Lawrence Talbot

University of California at Berkeley

Through the application of linearized theory a compressibility correction is obtained that gives the thrust or torque coefficient in subsonic flow, for a propeller or a helicopter rotor, directly from the incompressible flow values.

The blade element theory is applied to subsonic flow by introducing the linearized compressibility correction, while the first-order compressibility effect on the axial inflow is obtained from the simple momentum theory.

The subsonic compressibility correction for the lightly loaded propeller is found to be expressed in terms of the forward flight Mach Number and the Mach Number based on the rotational speed of the propeller tip. These relations are directly applicable to a helicopter rotor in vertical

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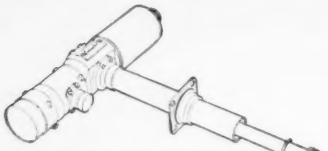

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flight and reduced to a simpler form depending only upon the rotational Mach Number at the rotor tip. It is shown that for the helicopter rotor a satisfactory approximation, for tip Mach Numbers less than 0.8, may be obtained by using the simple Prandtl-Glauert correction with the Mach Number given by the rotational speed at the $^3/_4$ radius.

The derived compressibility corrections are found to be in agreement with available experimental data. The limitations of the relations are analyzed by comparison with a numerical solution calculated from a more exact procedure.

A critical survey is made of other work on subsonic propeller theory. It is shown that in some cases fundamental mistakes have been made which result in considerable error in predicting the effect of compressibility.

Preprint No. 398

Transonic Flow Past Simple Bodies

By

J. D. Cole, G. E. Solomon, and W. W. Willmarth

California Institute of Technology

Transonic flow past conical tips, a lifting wedge, and a lifting flat plate is investigated theoretically and experimentally. Results on the drag and lift forces are presented. The existence of a closed smooth subsonic zone embedded in a supersonic flow field is demonstrated experimentally for transonic flow past conical tips. The cases discussed, together with the flow past wedge sections previously investigated, represent simple but fundamental cases for which the flow pattern from subsonic through sonic to supersonic flow can be obtained with relative ease. An understanding of these cases is extremely useful for handling the general transonic flow problem.

The Second-Order Lifting Pressure and Damping in Roll of Sweptback Rolling Airfoils at Supersonic Speeds

By

John C. Martin and Nathan Gerber

Ballistics Research Laboratories

The lifting pressure distribution and the damping in roll are determined for rolling sweptback airfoils with arbitrary cross sections. The time variation in the partial differential equation is eliminated by utilizing a set of coordinate axes that are attached to and rolling with the airfoil. The second-order lifting pressure is determined by an iterative method, and the damping in roll is calculated from the pressure distribution. The results are shown to agree well with available experimental data.

An Exact Solution for the Buckling Load of Flat Sandwich Panels with Loaded Edges Clamped

By

S. V. Nardo

Polytechnic Institute of Brooklyn

This paper presents an exact solution for the buckling load of flat rectangular plates whose loaded edges are clamped and unloaded edges simply supported. The theory is also shown to be applicable for the case in which unloaded edges are clamped and loaded edges simply supported.

The solution is based on small deflection theory, and it is assumed that the stresses are always below the proportional limit. The material for both the faces and the core is considered isotropic. Three equations of equilibrium, derived by means of the principle of virtual displacements, form the starting point of the theory. The equilibrium equations are partial linear differential equations with constant coefficients; two are of the second order, and the third is of the fourth order. Both the equations of equilibrium and 16 boundary conditions are satisfied identically.

Numerical calculations have been made for the case of loaded edges clamped. A series of design charts is presented which give the buckling load as a function of the plate aspect ratio and the ratio of core-to-plate thickness. Each curve is valid for a particular value of a parameter representing the ratio of shear rigidity to bending rigidity. Values of this latter parameter, which are four in number, are chosen to span the range encountered in most practical applications.

A check with experiments run at the Forest Products Laboratory indicates that the theory is in reasonable agreement with the experimental results.

Preprint No. 409

Airflow About Cone Cylinders with Curved Shock Waves

By

V. E. Bergdolt

Ballistic Research Laboratories, Aberdeen Proving Ground

Flows about 35° cone cylinders in free flight at Mach Numbers ranging from the régime of detached shocks to the region where completely supersonic Taylor-Maccoll flow has been established have been investigated with interferometric techniques. Measured fringe shifts from the

interferograms, density distributions, and the corresponding pressures have been compared with theoretical predictions and wind-tunnel data. Good agreement has been found with theory and other experiments.

Diffusers for Supersonic Wind Tunnels

By

J. Lukasiewicz

National Aeronautical Establishment, Canada

A systematic review of published experimental data relating to performance and design of wind-tunnel diffusers for entry Mach Numbers up to 10 is presented. It is found that:

(1) Compressibility effects are negligible in diffusers for $M < 0.9$.

(2) Shock compression is more efficient in constant area than in divergent ducts and usually requires appreciable duct length for completion.

(3) Pressure recovery of diffusers without contraction is improved by use of a long throat at entry but is always smaller than the theoretical normal shock recovery.

(4) At Mach Numbers below 4, maximum or starting contraction of constant geometry diffusers is closely predicted by simple theory, and better than normal shock pressure recoveries are achieved.

(5) With variable contraction diffusers, pressure recoveries of as much as twice the normal shock recovery are obtainable at hypersonic Mach Numbers. In general, optimum diffuser contraction angles increase with entry Mach Number increasing.

Aerodynamic Interference Between Moving Blade Rows

By

Nelson H. Kemp and W. R. Sears

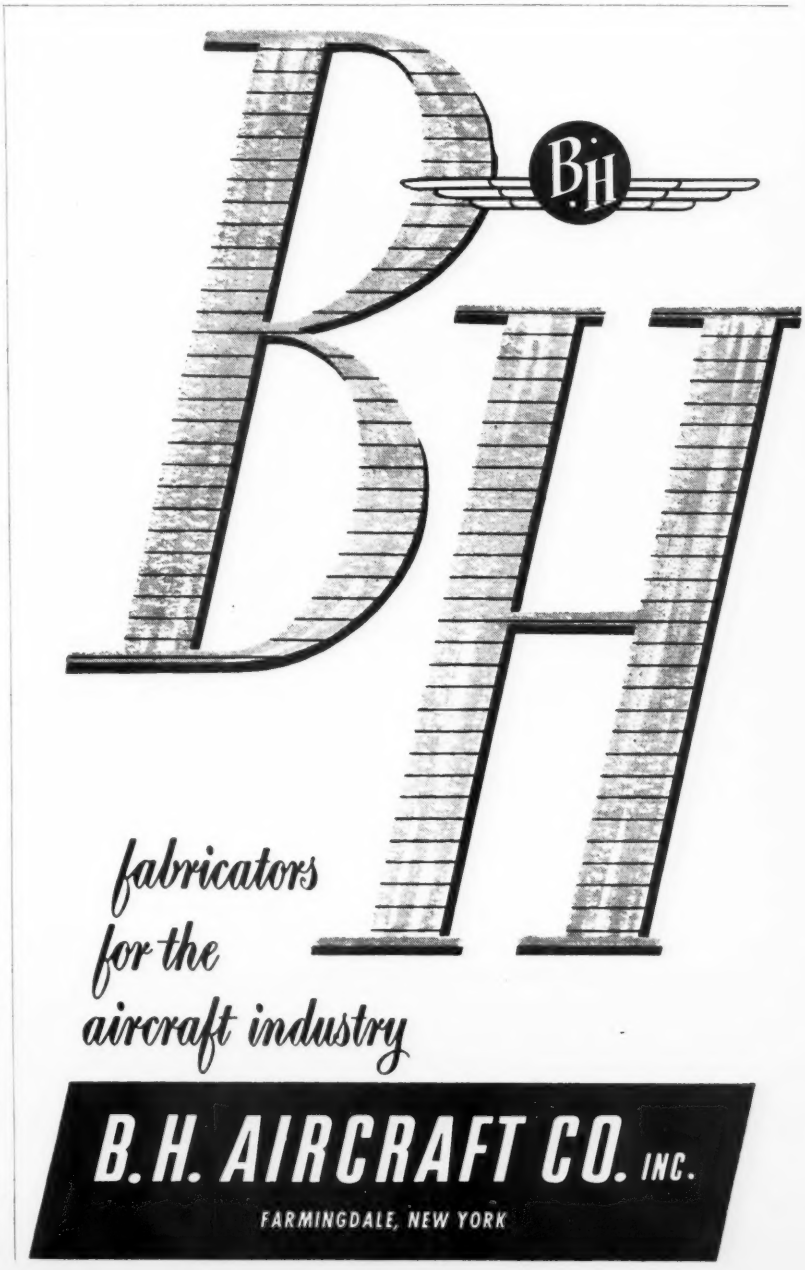
Graduate School of Aeronautical Engineering, Cornell University

The blades of a typical turbomachine move through a nonuniform field of flow, disturbed by the induced effects of other, stationary and moving, blade rows. In this paper the concepts and results of the theory of single thin airfoils in nonuniform motion are applied to calculate the resulting nonsteady effects on such blades. Incompressible inviscid flow is considered. The usual representation of blade wheels as infinite cascades of two-dimensional airfoils is adopted.

In this investigation, attention is confined to the basic case of a single stator row followed by a single moving rotor row. As a first approximation, it is assumed that, to calculate the nonsteady effects at any given blade, it is permissible to neglect the nonsteady parts of the circulation of all other blades. However, for the rotor blades, the effects of their passage through the vortex wakes shed by stator blades are also investigated. It is found that, with this approximation, the only results of thin-airfoil theory required can be obtained by a simple generalization of an earlier study of an airfoil flying through a sinusoidal gust pattern. Expressions are worked out for the unsteady components of lift and moment on stator and rotor blades.

Numerical calculations are carried out for some examples typical of compressor cascades. The results show fluctuating lift values with magnitudes as great as 18 per cent of the steady lift. The effects of stator wakes on the unsteady lift of rotor blades are found to be comparable to the induced effects of the stator blades themselves.

The rate of energy transfer to the wake pattern of the rotor-stator stage has also been calculated within the approximations of this theory, but the details are not presented here. For the compressor stages of the present numerical examples, it is found that this rate of energy transfer is a small fraction of the power required to turn the rotor.



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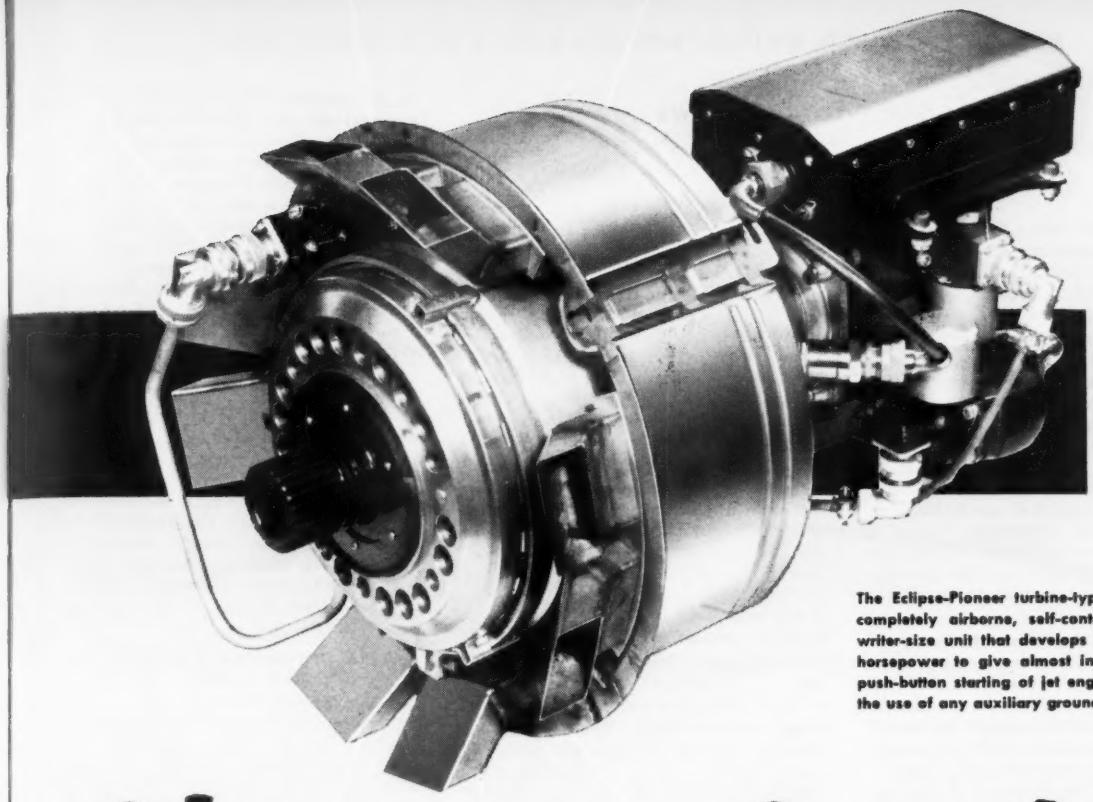

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(*Continued from page 21*)

to be consolidated into a single production unit. This consolidation will take place upon the completion of a new plant now being constructed on a recently purchased 23-acre site in Royal Oak Township, Mich. The new plant is expected to be ready for occupancy early in November.

• **Boeing Airplane Company and Pratt & Whitney Aircraft Division of United Aircraft Corporation . . .** Boeing recently announced that the power plants for the new prototype jet transport now under construction in Seattle will be Pratt & Whitney J-57 axial-flow gas-turbine engines. No details of either the engine or the transport were released. However, it was announced last year that Boeing's jet prototype is scheduled to fly during mid-1954.

• **The Bristol Aeroplane Company of Canada, Ltd. . . .** Three new versions of the Bristol Britannia air liner, Mark 200, 250, and 300, are to be offered for world sale. The Mark 200 will be a freight transport; the Mark 250, a mixed freight and passenger aircraft; and the Mark 300, a passenger air liner. The fuselages of the new Britannias will be 10 ft., 3 in. longer than the Britannia now in production, the Mark 100. The gross weight of the 200, 250, and 300 will be increased to 155,000 lbs., and they will be powered by Proteus 750 turboprops of 4,150 equivalent hp. Present schedules call for their production and delivery in 1956–1957. . . . Subject to official confirmation, a new world (Class C) altitude record was established last May by a British Canberra bomber powered by two Bristol Olympus turbojet engines. The reported altitude reached by the Olympus-powered Canberra was 63,668 ft. The Bristol Aeroplane Company's Assistant Chief Test Pilot, Wing Comdr. W. F. Gibb, was at the controls. The previous altitude record in this particular class was set in 1948 by Pilot Group Capt. J. Cunningham who reached an altitude of 59,446 ft.

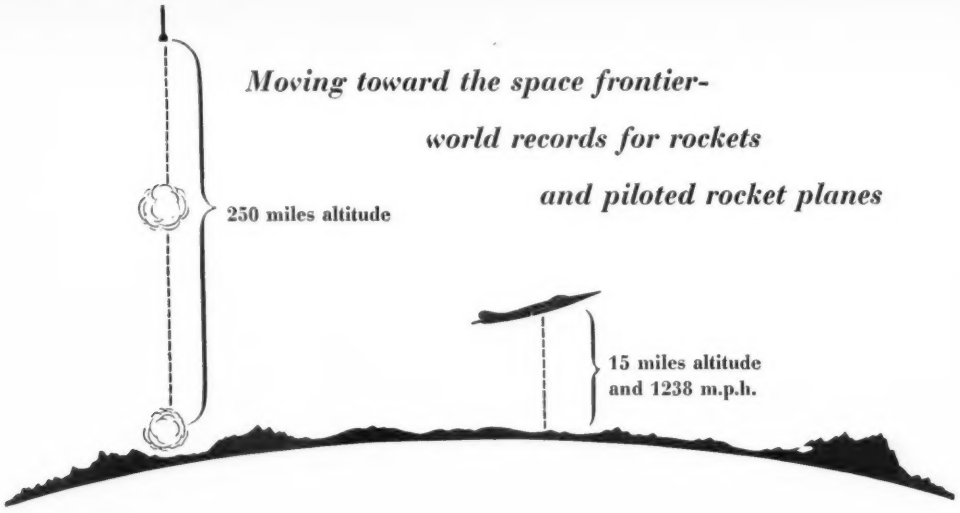
• **Chance Vought Aircraft Division, United Aircraft Corporation . . .** It was announced on May 21 by the Navy BuAer that Chance Vought had won a design competition for a new Navy day fighter. Although the details of the new jet fighter are being withheld until it is in operation, it was said that it will have a higher performance than previous Navy day fighters.

• **Consolidated Vultee Aircraft Corporation . . .** A $369,000 static test facility in which structural components of Navy flying boats undergo destructive static tests was placed in operation late last spring at San Diego. This huge steel dock is believed to be the largest fixture of its kind in the aircraft industry. The test chamber is built on a concrete foundation, measuring 100 by 196 by 3 ft., which is designed with tracks that can resist a load of 15,000 lbs. per ft. Steel columns support large steel trusses that are used to apply loads to seaplane wings, hulls, and various components. Maximum height of the structure is 67 ft., with ceiling heights of 56 ft. in one bay and 35 ft. in another. The structure itself is enclosed with Plastiglass siding for weather protection. Test recording equipment is installed in a separate building, 20 by 40 ft., which also has office space for engineering personnel. A view of this facility in operation can be found on page 58 of this issue. . . . In Floyd B. Odlum's sixth and final report as Convair's Chairman of the Board of Directors, he said that, following a large amount of B-36 business still ahead, the company will produce at San Diego a supersonic fighter and that meanwhile Convair is developing the "first truly supersonic long-range bomber planned for production at Fort Worth." At the meeting of May 15 at which this report was given, John Jay Hopkins, Board Chairman and President of General Dynamics Corporation, took over the position of Convair's Chairman of the Board. (For fuller details relative to Convair's new Board of Directors, please refer to the Convair item in the Corporate Member News Section of last month's issue of the REVIEW.)

• **Cornell Aeronautical Laboratory, Inc. . . .** The Cornell Committee for Transportation Safety Research, which instigates, promotes, and coordinates research programs in automobile and aviation safety, met at Cornell Aeronautical Laboratory on May 20. This committee is composed of representatives from Cornell University, The Cornell-Guggenheim Aviation Safety Center, Cornell Medical College in New York, and Cornell Aeronautical Laboratory. The program presented at this meeting included reports covering the work of the center, the medical college, and the laboratory, as well as several special reports. The topics reviewed included research in automobile crashes, airplane evacuation, aircraft fuel tanks, aircraft collision warning, aircraft noise, landing on slippery runways, shoulder harnesses, inflated seat backs, head gear, head impact, crash injuries, highway safety, operations analysis of automobile and aircraft travel, and statistics of expended medical time due to automobile accidents.

This DC-6A Airfreighter, manufactured by Douglas Aircraft Company, Inc., and owned by American Airlines, Inc., is the first such aircraft to have been built without windows. It is powered by four Pratt & Whitney 2,400-hp. Double-Wasp engines and can carry 30,000 lbs. at 310 m.p.h. in its 5,000 cu.ft. of cargo space. This particular aircraft, the Airfreighter Los Angeles, went into service last May 18 on a five-times-a-week round-trip schedule between Chicago and New York. Two more Airfreighters, which were to have been delivered to American last month, are being put into transcontinental service with coast-to-coast flights in each direction 5 days per week.

• **Douglas Aircraft Company, Inc. . . .** The DC-7 transport made its maiden flight at Santa Monica, Calif., on May 18. This particular DC-7 is the first of a fleet being built for American Airlines and scheduled for delivery to American later this year. Three other domestic air lines —United Air Lines, Inc.; Delta-Chicago & Southern Air Lines, Inc.; and National Airlines, Inc.—have also ordered DC-7's at this writing. This transport is powered by four Wright R-3350 turbo-compound engines driving Hamilton Standard 6921A-8 four-bladed propellers of a 13.5-ft. diameter. It has a top speed of 410 m.p.h. and a cruising speed of 365 m.p.h. The DC-7, which seats from 69 to 96 passengers, has a wing span of 117 ft., 6 in.; an overall length of 108 ft., 11 in.; and at the tail a height of 28 ft., 7 in., from the ground. . . . Over the Memorial Day week end, a DC-6B transport was flown nonstop from Los Angeles, Calif., to Paris, France, a distance of some 5,700 miles in 20 hours, 28 min. Carrying a crew of seven and a 104,080-lb. load at take-off, it left Los Angeles with 6,755 gals. of fuel

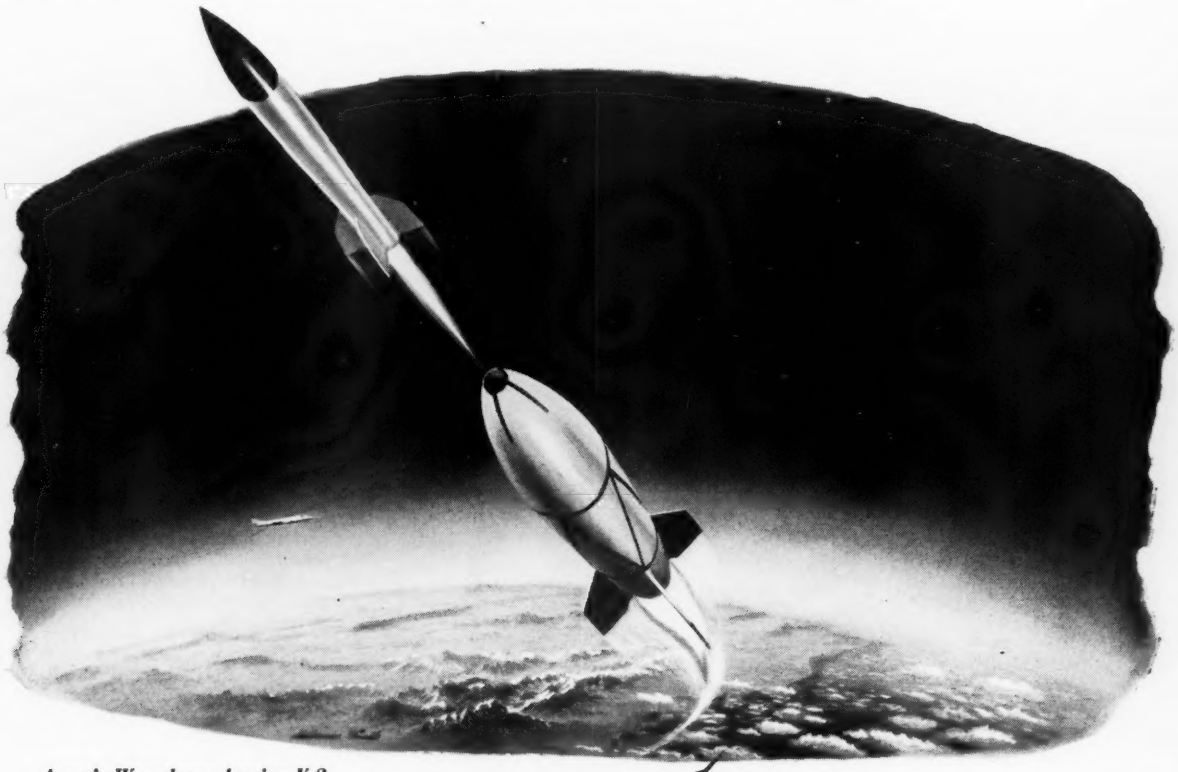


—the Douglas Skyrocket and Wac-Corporal

How soon will man cross the Space Frontier? Already, Douglas-built planes, rockets, and missiles—including the Wac-Corporal and D-558-2 Skyrocket—have probed at its fringes.

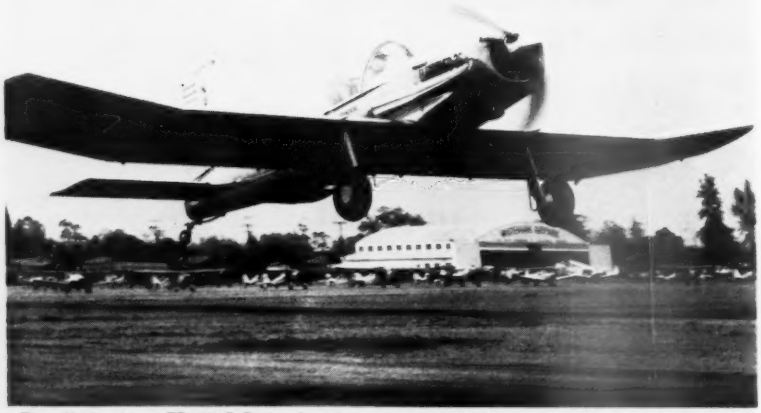
In a record climb, the Douglas D-558-2 reached an altitude where its pilot was *weightless*, as in a flight through space, while the Wac rocket, set in the nose of the V-2, travelled one-quarter of the way to the proposed orbit of a man-made satellite. Most important, both records came during *normal research*—planned to keep the United States and its Armed Forces out in front in the fields of guided missiles and supersonic aircraft.

Performance of Skyrocket and Wac-Corporal is proof of Douglas leadership in all phases of flight. *Farther and faster with a bigger payload* is the basic rule of Douglas design.



Army's Wac shown leaving V-2

Depend on *DOUGLAS* **First in Aviation**



The all-aluminum FD-25-B Defender, the second single-place ground-support aircraft to be built by Fletcher Aviation Corporation, made its first test flight on the last working day of May. The flight was of a 25-min. duration. The original prototype model, made of magnesium, is now in Tokyo, Japan, where the Toyo Aircraft Company is using it as a pattern to produce 50 of these "baby bombers" this year.

aboard and landed at Paris with 816 gals. remaining. The official take-off time was 7:28 a.m., PDT, May 28; touchdown was at 3:59 a.m., PDT, May 29. The DC-6B involved in this flight was the second of three being delivered to Transports Aeriens Intercontinentaux. . . . According to a recent company announcement, the Civil Aeronautics Board has ruled that "approximately 4,000 Douglas DC-3's flying commercial air lines throughout the world will be able to continue in scheduled passenger service indefinitely." In making this ruling, the Board said that the safety record of the DC-3 "indicates that these aircraft may be continued in scheduled passenger service without detrimental effect upon safety in air transportation." The DC-3 was first put into service in 1936.

• **Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation . . .** The eight hundred and fiftieth Flying Boxcar was delivered to the USAF on June 3. This number includes both C-82's and C-119's. The C-82, the first model of which was delivered to the USAF in the closing days of World War II, was "originally planned as a troop carrier to an anticipated invasion of the Japanese home islands." It continued in quantity production until 1948, when its successor, the C-119 Packet, began its production history. In addition to the fully assembled Flying Boxcars that have left the Fairchild plant in Hagerstown, Md., the company has delivered spares equivalent to at least another 200 airplanes.

The Lark," an antiaircraft guided missile produced by the Guided Missiles Division of Fairchild Engine and Airplane Corporation, is shown as it is being fired from the U.S.S. "Norton Sound." The design of this missile began under a Navy project during the latter months of World War II as a defense against the Kamikaze. The Lark is now being flown by all three branches of the Armed Services in their training and evaluation programs.

• **Fairchild Engine and Airplane Corporation . . .** The primary goal of a multimillion dollar research and development program recently approved by the corporation's Board of Directors is a "revolutionary, high-speed jet cargo transport capable of speeds in the neighborhood of 500 m.p.h."

• **Flight Safety Foundation, Inc. . . .** The site of the Flight Safety Foundation European Seminar has been transferred to England and is scheduled for September 9 to 11. Among those from the United States who will participate in exchanging air safety points of view with European operators and government agencies are: Dr. Ross McFarland, Associate Professor of Industrial Hygiene, School of Public Health, Harvard University; Col. J. S. Cochrane, USAF, Strategic Air Command; Dr. Barry King, Research Executive, Medical Division, CAA; and representatives from the U.S. Navy's Office of Naval Research and from the Search and Rescue divisions of the U.S. Coast Guard and Military Air Transport Service.

• **General Electric Company . . .** A "shock tube" that creates shock fronts has been constructed at Evendale by G-E jet-engine engineers. These shock fronts, which travel at supersonic speeds down the length of the tube, are photographed and studied to determine the effect of such waves on the combustion processes in jet engines. The shock tube is composed of two chambers, each of which is equipped with a glass window for high-speed photographic observations and is separated from the other by a thin diaphragm. In operation, pressure is first built up in one of the chambers, and the diaphragm separating them is then punctured. The pressure difference is great enough to create a supersonic shock wave as the gas rushes from the high-pressure chamber into the low-pressure chamber. . . . A new capacitor-discharge ignition system for aircraft jet engines, capable of starts at top jet speeds and altitudes, has been developed by G-E's Aeronautic and Ordnance Systems Division. This new system is said to be able to start jet engines at higher altitudes and lower temperatures than previously possible. It can be used in large and small gas turbines, jet starters, rockets, and ram-jets.

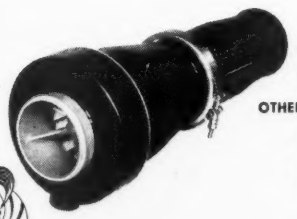
• **The B. F. Goodrich Company . . .** James J. Newman, a Vice-President of the company for 20 years, retired on last July 1. Mr. Newman had been with Goodrich since 1931, serving for the first 2 years of his association with the company as Assistant to the President.

• **The Goodyear Tire & Rubber Company . . .** The second ZP2N "Nan"-type blimp, constructed for the Navy by Goodyear Aircraft Corporation, was launched and test flown on May 19 at the

STOP COCKPIT FOG

When aircraft fly under high humidity conditions, air leaving the air conditioning system often becomes super-saturated. Immediate fogging and condensation on cool surfaces such as the canopy glass and instruments results. Since this undesirable condition is most likely to occur at low level it constitutes a severe flight hazard, particularly during a landing or take-off.

By removing 80 per cent of the entrained moisture, Stratos Air-Moisture Separators stop cockpit fogging and eliminate the hazard. They are small and light. Completely self contained, they are installed in the cabin air duct line downstream of the cooling unit. No source of power other than the flowing air is needed. First installation of these centrifugal separators is being made by Boeing — whose engineers established the design requirements and did the original research — in the B-47 "Stratojet".



AIR MOISTURE SEPARATOR

Model MS60 • Rated Flow 64 #/min.
Weight 5.5 lbs Duct Dia 4"

OTHER MODELS

MS20 • Rated Flow 20 #/min.
Weight 3 lbs Duct Dia 2.5"
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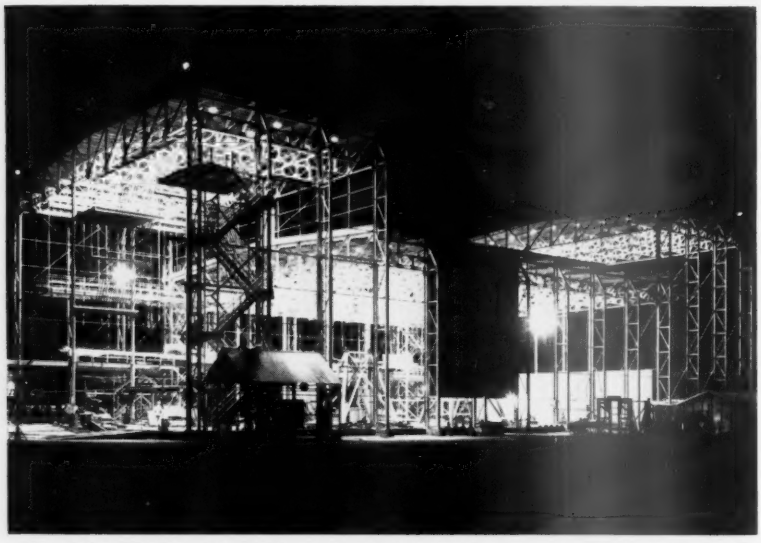


Consolidated Vultee Aircraft Corporation's static test facility, recently constructed at San Diego, is shown in operation in this night scene. Further information concerning this facility may be found in the Convair item on page 54 of this issue.

Akron (Ohio) Municipal Airport. The first ZP2N blimp was launched at Akron on March 20. These ships, the largest nonrigid airships ever built, have an envelope capacity of 975,000 cu.ft. of helium gas.

• **Jack & Heintz, Inc.** . . . Sydney D. Mahan, Director of Public Relations and Advertising, died of a heart attack on May 22.

• **The M. W. Kellogg Company** . . . *Technical Bulletin No. 1-3-53*, which contains new data on chemical resistance, permeability, and optical properties of Kel-F, is now available from the Technical Service Department of Kellogg's Chemical Manufacturing Division.

• **Lear, Incorporated** . . . Harold R. Boyer and Charles Luckman were elected to Lear's Board of Directors on May 22. Mr. Boyer is Manager of General Motors Corporation's Cleveland Cadillac plant, and Mr. Luckman is a member of the architectural firm of Pereira and Luckman, of Los Angeles. Russell A. Stevenson, Dean of the University of Michigan's School of Business Administration, is acting as Assistant to William P. Lear, AFIAS, in connection with his activities as Chairman of the Board. . . . At the June 5 meeting of the Board of Directors, A. Rorison was elected Assistant Treasurer.

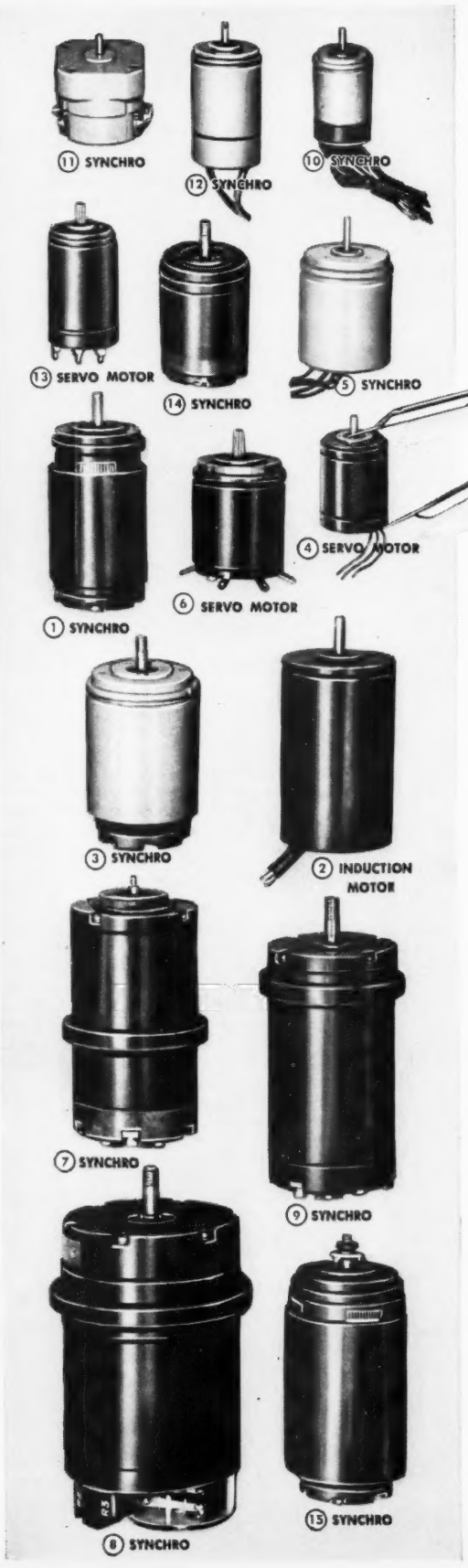
• **Lockheed Aircraft Corporation** . . . A 9,600-cu.ft. icing wind tunnel is being completed at Lockheed and will be fully operating some time this month. This $130,000 installation, said to be the largest privately owned icing tunnel ever projected, is to be used by research engineers to improve methods of eliminating ice from airplanes, and it supplements other research devices at Lockheed designed to create rain, sleet, desert heat, jungle humidity, or sandstorms for prechecking equipment under all conditions. This icing tunnel, which is chilled by a 1,165,000-B.t.u.-hr. refrigeration system, measures 76.5 ft. in length and 17 ft. in height. The design of this new facility calls for test of aircraft components at a simulated speed of 200 m.p.h. at zero temperature; however, higher speeds can be duplicated in the upper freezing range, and slower speeds can be duplicated at temperatures as low as −50°. . . . The final T-33 jet trainer assembly line has been changed over from a manual-move system to a nonstop mechanized operation. This project, which cost $60,000, was begun about May 27 and was scheduled for completion the first of this month. It is estimated that this mechanized line will cut final assembly time by approximately 25 hours per airplane on the T-33 (or the TV-2, as it is designated by the U.S. Navy).

• **Minneapolis-Honeywell Regulator Company** . . . A three-color booklet recently published by the company describes the line of automatic control products made by the Aeronautical Division for the aircraft industry. This booklet, entitled *Everything Under Control*, gives a brief outline of the firm's activity in the aeronautical field and illustrates the automatic control components utilized in high-speed aircraft. It may be obtained from Minneapolis-Honeywell's Aeronautical Division. . . . Another booklet recently put out by the Aeronautical Division is *Helicopter Autopilot*. This four-page illustrated booklet, which may be obtained from the Aeronautical Division, describes the operation of the company's new helicopter autopilot.

• **North American Aviation, Inc.** . . . The latest version of the Sabre, the F-86H, completed its first flight last May at Edwards AFB, Calif. This ship, which was designed to carry out dual missions as a fighter-bomber and a day fighter, is powered by a General Electric J-73 jet engine. Compared with the earlier versions of the Sabre, the "H" is slightly larger, has a sturdier landing gear, and has improved suspension and release mechanisms for carrying droppable wing tanks in conjunction with bombs and rockets for its fighter-bomber role. Its canopy is of the clamshell type. The plane carries six 0.50-cal. machine guns. All of its controls are hydraulically operated with an all-movable horizontal stabilizer replacing elevators for greater pilot control. The "H" is in the 650-m.p.h. class and has a combat radius of over 600 miles and a service ceiling of over 45,000 ft. It is being produced at North American's plant in Columbus, Ohio. . . . An 18-lb. fireproof and crashproof airborne tape recorder, known as NADAR (North American Data Airborne Recorder), has been designed to log everything that happens during an airplane or missile flight. This unit, which can be carried on commercial, military, or private aircraft, has a 1,200-ft. magnetic tape locked in a sealed and crashproof case. This tape can record important information during a flight as long as 10 hours; it can be used for another 10 hours nonstop with the previous information being "wiped off" as the new information is recorded. The information logged by NADAR includes conversation in the cockpit, communications from the ground, and data on pressure, altitude, time elapse, vertical acceleration, air speed, and direction. The complete recording unit is about the size of a portable typewriter and fits snugly into wing roots or luggage compartments.

• **Northrop Aircraft, Inc.** . . . A "highly effective" thermal anti-icing system in the F-89D Scorpion was recently announced by Northrop engineers. In this system, hot air is bled from the engines and is then ducted to the various surfaces where it is used to heat the outer skin to prevent or remove ice formations. The company's engineers point out that this system does not disturb the clean lines of the airplane by external attachments. . . . On May 28, the company announced the sale of its school division, Northrop Aeronautical Institute, and its merger with the California Flyers School of Aeronautics, of Inglewood, Calif. The combined operation is continuing under the name of Northrop Aeronautical Institute and is now situated at Arbor Vitae and Florence Avenues in Inglewood. The formal move of N.A.I. personnel from Northrop Aircraft's Hawthorne property to the California Flyers location in Inglewood was begun on June 19, during the school vacation, and was completed in time for the students to report for classes at the new location on July 6. The grounds and buildings formerly occupied by N.A.I. at Northrop's Hawthorne property are now being used in the company's research and manufacturing program for the U.S. Government. John K. Northrop, FIAS, who retired in 1952 as President of Northrop Aircraft, is associated with the school as a Technical Adviser.

• **The Parker Appliance Company** . . . Parker Aircraft Company, a subsidiary of Parker Appliance, has acquired Proof Industries Corporation's complete line of aircraft hydraulic directional control valves along with Proof's order backlog on these products amounting to approximately $1,000,000. This transaction, which was announced on May 19, in-



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3. SYNCHRO, Size 18, O.D. 1.750", 115 V, 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
4. SERVO MOTOR, O.D. .937", 26V, 400 Cycles
5. SYNCHRO, O.D. 1.437", 14.4 V and 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
6. SERVO MOTOR Mk 7, O.D. 1.437", 115 V, 400 Cycles
7. SYNCHRO, Type 1F or 1HG, O.D. 2.250" 115 V, 60 Cycles *(Receiver, Transmitter)*
8. SYNCHRO, Size 31, O.D. 3.10", 115 V 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
9. SYNCHRO, Size 23, O.D. 2.250", 26 V and 115 V 400 & 60 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
10. SYNCHRO, O.D. .937", 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
11. LINEAR TYPE CONTROL TRANSFORMER, O.D. 1.625", 26 V, 400 Cycles
12. SYNCHRO, Size 11, O.D. 1.062", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
13. SERVO MOTOR, O.D. 1.062", 115 V, 400 Cycles
14. SYNCHRO, Size 15, O.D. 1.437", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
15. SYNCHRO, Size 19, O.D. 1.90", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transmitter)*

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MANUFACTURE ...of precision instruments, components, and systems.

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- RESEARCH & DEVELOPMENT DIVISION

cluded leasing of Proof's plant and facilities at 10000 Exposition Blvd., Los Angeles, which will now operate as the Proof Division of the Parker Aircraft Company. Henry Trich, MIAS, has been retained as Manager of the new division. Proof Industries Corporation will continue the manufacture of other products at its Cleveland plant.

• **Piasecki Helicopter Corporation** . . . A Canadian subsidiary, known as Piasecki Helicopter Company of Canada, has been formed. This subsidiary, located near Ottawa, is concentrating initially on supplying service and overhaul facilities for the six Piasecki H-21A's ordered by the RCAF.

• **Scintilla Magneto Division, Bendix Aviation Corporation** . . . A plant expansion of 8,500 sq.ft. of office floor space was scheduled to be completed by the middle of last month. This is the fifth plant expansion since the beginning of the Korean fighting.

• **Servomechanisms, Inc.** . . . The corporate offices have been moved from the company's Westbury Division, Westbury, N.Y., to a new office building located at 500 Franklin Ave., Garden City, N.Y. This move is intended to facilitate liaison between the corporation's several divisions and at the same time to provide much needed space at the Westbury Division.

• **Solar Aircraft Company** . . . A booklet entitled *Unique New Stainless Alloy Products for the Oil and Chemical Industries* is now available from Solar. Solar products described in this booklet include industrial expansion joints, 50- and 500-hp. gas-turbine power plants, ceramic coatings for use on metals subject to high-temperature service, shell mold castings of stainless alloys, and custom-designed items made of stainless steels or super alloys.

• **Summers Gyroscope Company** . . . Lloyd L. Hill has been appointed Vice-President and General Manager of Summers. Mr. Hill, an accredited C.P.A. in both Illinois and California, was previously Controller and Assistant to the General Manager at Summers.

• **Tinnerman Products, Inc.** . . . The company recently announced a new line of spring-tension Push-On type of SPEED NUTS, known as C12000 series and now available in most sizes. These fasteners provide a positive bite that holds integral studs, rivets, tubing, and other unthreaded parts in vibration-proof attachment. They are said to cover a wide range of popular stud sizes and to meet the requirements of most applications. The new C12000 series of spring-tension fasteners is available for round, rectangular, or "D"-shaped studs. When pressed over a "D"-shaped stud with the prongs parallel to the flat of the stud, the new Push-On type of SPEED NUT can be removed quickly and easily by turning it 90° by hand.

• **Vard, Inc.** . . . According to a recent release, a new line of ball screwjacks has been developed by Vard engineers which utilizes physical principles of screw expansion and the near-frictionless spacer ball coupled with tolerances up to 0.0004 in the ball-bearing races. Vard ball screwjacks are made up with a mating nut and screw, each having helical races. The ball circuit is closed with a return tube attached to the nut. This, it is said, allows the ball bearings to circulate freely, resulting in the transmission of rotary motion to linear motion with an absolute minimum of loss due to friction. Standard sizes, from $^3/_8$ in. to 4 in. in diameter and up to 22 ft. in length, are now being furnished. Ball screwjacks will also be manufactured to engineering specifications for any specific application in which transmission of rotary motion into linear motion is required.

• **Vickers, Inc.** . . . *Brochure 15205*, recently published by Vickers, describes the company's complete line of standard 3,000-lb. per sq.in. hydraulic motors for aircraft. It may be had by writing to the Detroit office.

• **Westinghouse Electric Corporation** . . . The engineering facilities of the Electronics Division are being expanded to include a new engineering subdivision to be known as "Guided Missile Ground Control Engineering." This section will concern itself exclusively with the development, design, and manufacture of models and equipment for guidance of high-speed high-altitude missiles. This new subdivision will eventually be housed in its own building adjacent to the company's microwave manufacturing plant in Baltimore.

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COMPACTNESS . . .
PERFORMANCE . . .
All Often Improved with . . .

Lamb Electric
SPECIAL APPLICATION
FRACTIONAL HORSEPOWER
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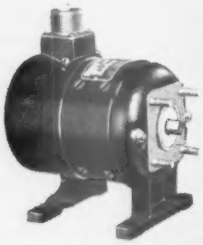
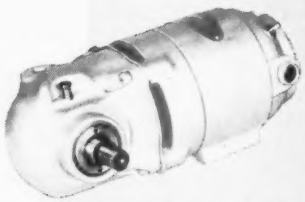


Intermittent high torque motor with low weight factor; for aircraft and many other applications.

• You may find, as have many other designers of motor-driven products, that the use of a special application Lamb Electric Motor will enable you to reduce costs.

Compactness . . . low weight . . . excellent performance — these are some of the other advantages obtained with Lamb Electric Motors, because they are *specially engineered* for the application.



Space factor in this power unit is minimized by having output shaft at right angles to motor shaft.

The Lamb Electric Company
Kent, Ohio

In Canada: Lamb Electric — Division of Sangamo Company Ltd.— Leaside, Ontario

THEY'RE POWERING
AMERICA'S *Finest* PRODUCTS

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SPECIAL APPLICATION
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MOTORS

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Meet Your Section Chairman

Capt. William C. Fortune, USN

Washington Section

When Capt. William Charles Fortune, USN, AFIAS, was a boy in Salamanca, N.Y., where he was born on March 1, 1911, he was regaled with stories of the infant aeronautical industry. The tellers of the tales were two uncles, one of whom had been a Naval Aviator in World War I and had flown with Major Al Williams and the other who was a close friend of Brig. Gen. Benjamin S. Kelsey, USAF, then one of the U.S. Army's top test pilots and now Deputy Director, Research and Development, USAF.

While these aeronautical descriptions were undoubtedly intriguing, young Fortune had not seriously considered aviation as a career when he was admitted in 1929 to the U.S. Naval Academy. A flight in 1930 with General Kelsey tipped the scales in favor of aviation, and Midshipman Fortune was sold.

After graduating from the Academy in 1933 with a B.S. degree in Electrical Engineering, he spent 2 years as a junior officer with deck, engineering, and gunnery duties before making his first professional step in the aeronautical field. That was an assignment aboard the U.S.S. "Texas" as an Aviation Observer. The next step—a big one—was made in February of 1936, when he was sent to Pensacola NAS, Fla., to train as a Naval Aviator. After completing the course at Pensacola, he was assigned to scout-bomber squadrons aboard the U.S.S. "Saratoga," "Ranger," and "San Francisco." In 1937, he became a member of the elite Caterpillar Club as a result of a mid-air collision during a camera-gunnery run.

In 1939, he was sent to the U.S. Naval Postgraduate School and 2 years later was transferred to Massachusetts Institute of Technology. At M.I.T., he wrote a thesis on the "Influence of Cylinder Injection on the Tendency to Detonate" and in June of 1942 was awarded an M.S. degree in Aeronautical Engineering.

For the next 16 months or so, Captain Fortune helped install and test catapults and arresting gear on all of the new carriers and served as catapult test pilot at the Naval Aircraft Factory. In October of 1943, he was ordered to ComAirPac where he continued looking after the same type of equipment. He was reassigned to NAF in April of 1945 and a few months later became Chief Engineer, a position that he held for 3 years.

Between 1948 and 1950, he was a BuAer Representative for jet propulsion matters in the Pasadena, Calif., area. After being transferred to ComFairJapan for several months as Assistant Chief of Staff for Logistics, he was returned to the States in 1951 to assume his present duties as Head, Aerodynamics Laboratory, David Taylor Model Basin. As such, he is concerned with direct research and development tests of aircraft and guided-missile models in the two 8- by 10-ft. subsonic, a 7- by 10-ft. transonic, and the three intermittent supersonic wind tunnels.

Captain Fortune has compiled a list of events that he considers to be the most interesting ones in his career. In this list are: the 1937 mid-air collision, a good-will cruise around South America in 1939, test flying at the NAF, trying to keep the carriers operating during World War II, and trying to keep carriers and Marines in aircraft in the Korean area.

Captain Fortune, who has logged some 2,800 hours as a pilot, enjoys golf, fishing, and gardening in his spare time. He was married in 1935 to Libby Offutt. They have three children: Elaine, aged 17, Wealtha, aged 10, and Laurie, aged 9.

IAS Sections

Atlanta Section

Edith Hall Lively, *Secretary*

The regular April meeting of the Atlanta Section took place on the fifteenth in the Georgia Tech Dining Hall. Chairman George Baughman presided. The speaker on this occasion was Ernest B. Evans, of the Engineering Test Laboratory, Georgia Division, Lockheed Aircraft Corporation, who discussed "Avoidance of Trouble in Aircraft Electrical Installation."

A brief summary of his talk consists of the following points:

Avoidance of trouble begins with the designer, who should make use of all available aid and information in the first place and who then should check and recheck all circuits and layouts, hunting for any possible malfunction that could be caused by misuse or abuse. This should be done particularly with new circuits and components.

Coordination and cooperation among the various design groups is important so that operation and/or testing of one part will not damage or interfere with the operation of another. Minor faults in simple circuits or minor components sometimes cause serious trouble; yet they are easily overlooked when checking.

Certain forms of trouble have occurred repeatedly because the causes have not been stressed, and, hence, the designers may be unaware of them. In protective systems, care must be taken that no single failure can cause a fault and at the same time render inoperative the fault protection.

Safety is of prime importance in both the building and the future servicing of an airplane. Certain precautions should be especially emphasized:

(a) A gasoline tank presumed to be empty may contain explosive vapors.

(b) Precautions should be taken to avoid battery explosions.

(c) It may be hazardous to expose the body and certain materials to radar beams.

In something as complex as the building of an airplane, caution and every possible precaution should be taken to prevent trouble before it appears.

A question-and-answer period and general discussion brought the meeting to a close.

Baltimore Section

J. Francis Maloney, *Secretary*

The May 13 meeting of the Baltimore Section was held at The Johns Hopkins University. An audience of 100 attentive members and guests was present

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Indicative of the versatility of the G-R Type 1532-B Strobolume is an unusual method for the visualization of air flow, described by Prof. F. N. M. Brown, Head of the Dept. of Aeronautical Engineering at the University of Notre Dame.

"This short-interval, high-intensity flash source has enabled us to photograph and study a wide variety of fundamental aerodynamic problems.

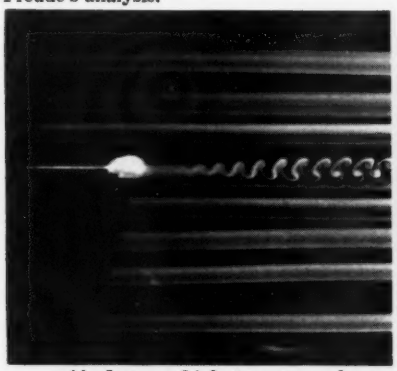
Briefly, the technique employs a small, easily-constructed, low-turbulence wind-tunnel with a transparent working section in which the model is placed. Smoke produced by the coking of grain straw is introduced just upstream of the antiturbulence screening. It flows with the air stream over and around the model at speeds ranging from fifteen to one hundred seventy-five feet per second.

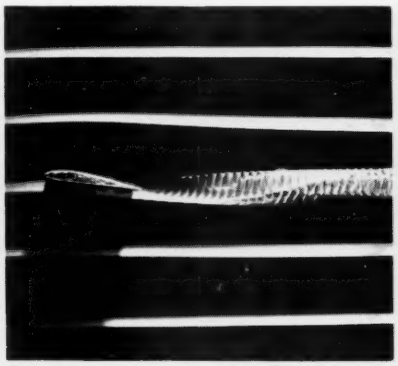
The Strobolume's short duration white flash is 2000 times as intense as the flash of an ordinary stroboscope. The instrument permits single-exposure still photography of periodic aerodynamic phenomena whose frequencies may range as high as six thousand per second. This is accomplished with conventional camera equipment and lens aperatures as small as f/6.3.

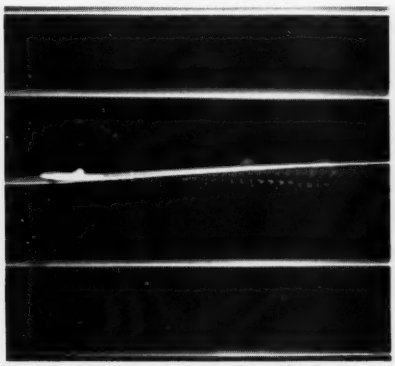
Successful motion pictures of low frequency aerodynamic phenomena also have been made at rates as high as 64 frames per second. In this application the Strobolumes were tripped by a rotary switch driven by the camera motor."

Studies conducted with the "visualization technique" have brought forth both facts and speculation which offer the imaginative aerodynamicist new material for thought.

For example, photographs of transitioning boundary layers, where transition is due to an adverse pressure gradient, reveal that actual vortices are formed and that the frequency is surprisingly regular. Study of unobstructed flow at various speeds shows that wind turbulence is not a constant, but is a function of speed, and that the decay time between screening at the end of the pressure chamber and the object under study is of greater importance than has been hitherto thought. Even casual inspection of photographic studies indicates the accuracy of the vortex theory and the long appreciated disapplication of Freude's analysis.







Air flows at 24 feet per second around a sharpened, flat plate. From such photographs, Mr. Brown has concluded that the vortex discharge is a function of the velocity to the three-halves power and of the length to the minus one-half power.

Studies of tip vortices reveal what appears to be a single, continuously-formed vortex of helical form having as its axis the core of the commonly recognized tip vortex. Inasmuch as a similar detail appears in the tip vortex of a sharpened, elliptical plan form plate, it is believed to be a part of every tip-vortex. The varying period and strength with tip form may explain the so-called "wing end drags" used by some German aerodynamicists.

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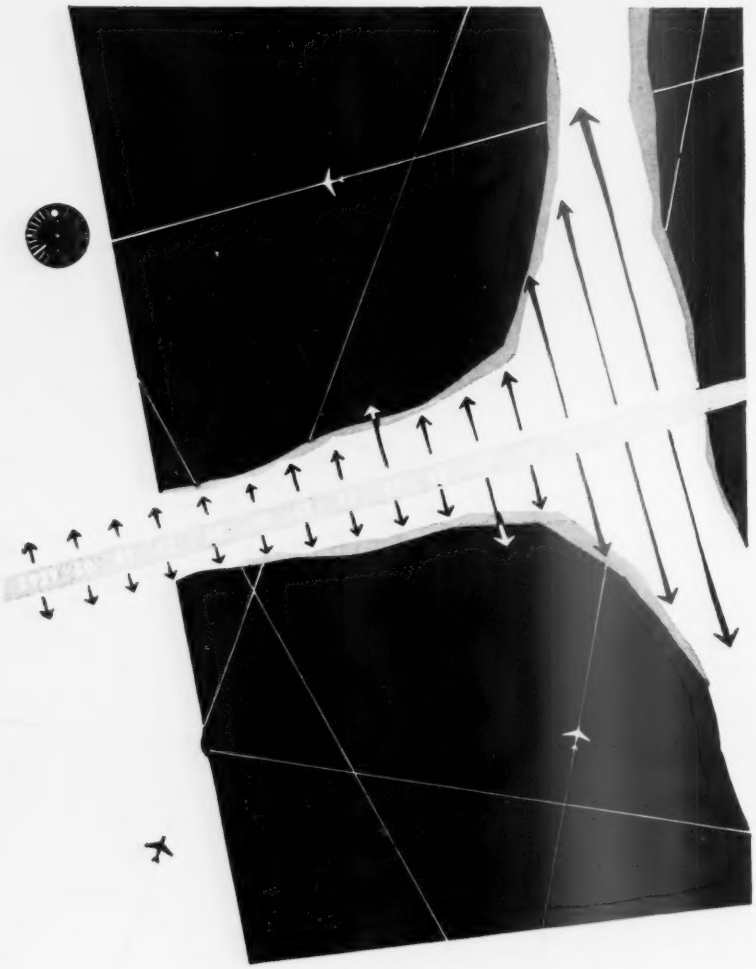

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to hear Major Gen. Donald L. Putt, USAF, Vice Commander, Air Research and Development Command, speak on "The Systems Approach to Air Weapons Development."

A complete weapons system includes a vehicle with its armament, radio, navigation, photographic, and other components, plus all ground supporting equipment and operating bases.

Major national systems may be divided into economical, political, social, and military. The military may be further divided into land warfare, sea warfare, and air warfare. Air warfare is subdivided into air transport, psychological, tactical, air defense, and strategic, and these, in turn, may be further subdivided.

The British, during World War II, used the systems approach as a means of increasing the effectiveness of existing weapons. As an example, they removed deicers from their aircraft because operational analysis proved that more overall benefit was derived by the saving in weight, etc., which permitted more range and heavier bomb loads.

The high cost and time involved to develop new weapons necessitates careful analysis of alternate approaches and the selection of the most feasible approach. The systems engineering approach has long been applied in other fields, such as large electrical-power-distribution installations.

The first step in the U.S. Air Force is the establishment of the development-planning objective, which, in a broad sense, evaluates the technical feasibility. The second step sets up the general operational requirements. Next, the third step involves the preparation of a development plan by the Air Research and Development Command. The plan is forwarded to the appropriate ARDC centers, one of which is appointed coordinating agency. Design studies may then be obtained from contractors. Approval of Headquarters, USAF, is obtained and development directives issued to the centers.

The advantage of this system is that the U.S. Air Force deals with one prime contractor who is responsible for all his broad base of subcontractors. This stimulates the maximum possible amount of subcontracting. Of course, there is still a large program of direct prime contracts for components where such a procedure is advantageous to the U.S. Air Force.

Objectives of the systems approach are the elimination of overproduction of underdeveloped equipment and the production on time of top quality and necessary quantity of integrated equipment and trained personnel.

General Putt's speech was well received and provoked a lively discussion

period mostly concerned with the cost and time aspects of the systems approach.

Boston Section

E. A. McBride, *Secretary*

Dr. C. C. Furnas, noted Aeronautical Engineer, who is Director, Cornell Aeronautical Laboratory, Inc., was the speaker at the April 13 meeting. The meeting, held at Raytheon Manufacturing Company, Waltham, Mass., was called to order at 8:00 p.m. by Chairman R. L. Bisplinghoff.

An attentive audience of approximately 100 members and guests enjoyed Dr. Furnas' lecture, "Future Trends in Aviation." He covered a great many of the problems being encountered with fuels, propulsion plants, speed, and safety in the design of future aircraft. His most encouraging comments, however, had to do with astronautics and the predicted accomplishments in the not-too-distant future.

The Boston Section was honored to have as a visitor from New York, S. Paul Johnston, Director of the Institute. After a few words from Mr. Johnston, the meeting was adjourned, and refreshments were served through the courtesy of Raytheon.

Buffalo Section

George B. Melrose, Jr., *Secretary*

The May 13 meeting of the Buffalo Section digressed somewhat from a purely aeronautic topic and featured a tour of the Lackawanna Plant of Bethlehem Steel Company. The membership supported this program to such an extent that it was necessary to arrange two tours in order to accommodate the 70 members who made the visit. The detailed arrangements were ably handled by Ron Crisman.

The Lackawanna Steel Plant is the third largest steel producing facility in the country and has a yearly output of approximately 5,000,000 tons. The mammoth facilities of this installation include 500 coke ovens, seven blast furnaces, 34 open-hearth furnaces, plus hot- and cold-rolling mills that process practically the entire output of the plant.

The tours, which lasted about 4 hours, included visits to the major installations and descriptions of their operations. The trip included inspection of the ore unloading docks, coke ovens, blast furnaces, open-hearth furnaces, soaking pits, blooming and billet mills, and the hot-rolling and cold-rolling sheet and strip mills. The tour was most interesting and was thoroughly enjoyed by all.

This picture taken at the April 28 meeting of the Hampton Roads Section, shows (*left to right*): Dr. Henry J. E. Reid, Director of NACA Langley; Major Al J. Williams, USMCR; and Colonel Jones, Langley AFB, Va. Colonel Jones is holding a model of a Curtiss military racer flown in 1925 by Major Williams.

Hampton Roads Section

H. Herbert Jackson, *Recording Secretary*

The Hampton Roads Section held its first Annual Dinner Meeting the evening of April 28. The dinner was preceded by a cocktail and social hour, and following the dinner the 102 members, wives, and guests were addressed by Major "Al" J. Williams who now resides at "The Eyrie," Elizabeth City, N.C.

Major Williams was introduced by Dr. Henry J. E. Reid, of NACA. He gave those attending an interesting review of his colorful career of three decades in aviation.

Major Williams served as Naval Aviator in World War I and, later, as an Instructor. Prior to that he was well known as a no-hit, no-run pitcher under John J. McGraw, of the big league New York Giants.

He pioneered spin studies and problems of inverted flight and won the Distinguished Flying Cross in 1929 for his work as Chief Test Pilot for the Navy. In 1923, he won the Pulitzer Trophy Race and established three world speed records.

In 1925, he recorded the first 300-m.p.h. speed record in a Curtiss military racer and in 1928 conducted the first and only complete flight research with the Curtiss Hawk fighter. He became a Major in the U.S. Marine Corps Reserve in 1935.

In 1933, Major Williams flew the "Gulfhawk I" Grumman F3F as Aviation Sales Manager for Gulf Oil Corporation. He became the first non-German to fly the Messerschmidt Me-109 in 1938. This was an exchange flight with German General Udet who flew the Gulfhawk. In 1948, he was presented an award for individual flying performance in the Gulfhawk (F8F) at the opening of Idlewild International Airport. In October of that same year, the F3F Gulfhawk gave its last performance before 200 dignitaries and was then presented to the Smithsonian Institution as "the plane that taught young America to fly."

Major Williams' review of some of his more humorous incidents in the early days of flying drew many a chuckle from those attending. The photographs covering his career in aviation, which were posted, also drew a great deal of interest during the social hour.

Los Angeles Section

Harold S. Fischer, *Secretary*

Section activity during the month of May included two specialist meetings, the monthly dinner meeting, and the annual spring dance.

On May 14, H. P. Eichenberger, Preliminary Design Engineer, AiResearch Manufacturing Company, Los Angeles, addressed a specialist meeting on "Secondary Flow in a Cascade of Airfoils." He presented experimental results he obtained from tests on flow in a curved channel which simulated the passage between two blades of a cascade. Defining secondary flow as the difference between potential flow and flow with a varying stagnation pressure, Mr. Eichenberger developed a theory that allows the designer to calculate the secondary flow and to apply corresponding corrections to blades designed on the basis of potential flow.

▶ Two speakers, both Project Engineers of J. B. Rea Company, Inc., discussed related subjects at a specialist meeting held on May 21 at the IAS Los Angeles Building. J. R. Shull spoke on "An Automatic Cruise Control Computer for Long-Range Aircraft." Mr. Shull, who has specialized in the synthesis and

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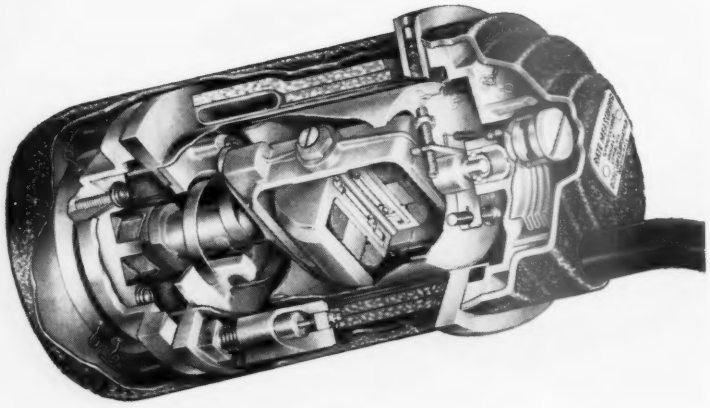

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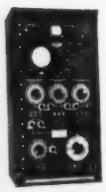

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development of aircraft servosystems, is coinventor of the optimalizing control mechanism used in the cruise control computer. This device automatically determines the best power setting for maximum range of an aircraft under all flight conditions. Eric Weiss discussed "Digital Techniques as Applied to Autopilots; Expected Advantages of a Digital Autopilot over Conventional Present-Day Analog Equipment." Mr. Weiss, who has been in the digital-computer field practically from its inception, did the logical design of Maddida 44A, CRC 105, as well as several special-purpose digital computers. He discussed the philosophy behind the design of a simple digital autopilot being developed by J. B. Rea Company, Inc.

▶ The fourth annual Spring Test Hop was held on May 16 in the auditorium of the Institute Building. The motif was "Gay Paris," and an effective transformation of the hall was achieved. About 150 couples "filled the house" for this popular annual dance, which was judged an unqualified success.

▶ The May Dinner Meeting featured Major Gen. Donald L. Putt, Vice Commander, Air Research and Development Command, USAF, whose subject was "The Systems Approach to Air Weapons Development." For a discussion of this speech, see the Baltimore Section report on page 64.

General Putt's distinguished career in the USAF is well known to most members, since he has been closely associated with engineering development. In recent years, he has held successive appointments as Deputy Chief of the Engineering Division, Air Materiel Command, Wright-Patterson AFB, Ohio; Director of Research and Development, Headquarters, USAF; and Assistant Deputy Chief of Staff, Development Headquarters, USAF. General Putt is a member of the Research and Development Board and of the National Advisory Committee for Aeronautics.

An audience of approximately 400 attended the address by General Putt. Among aeronautical personages present were Dr. Theodore von Kármán; Professor Itiro Tani, of the University of Tokyo; and Brig. Gen. Stanley Holtoner, Commanding Officer, Edwards AFB, Calif.

Montreal Section

G. Rosenthal, *Secretary*

The final meeting of the 1952–1953 season was held at the RCAF 401 Fighter Squadron Mess on May 11. Business of the Section was covered in the first part of the program, including the election of officers for 1953–1954. The officers elected are: Chairman,

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A. E. Ades; Vice-Chairman, R. H. Guthrie; Secretary, G. Rosenthal; and Treasurer, Squadron Leader E. E. McCullough.

E. H. Higgins presided as Chairman and later introduced the guest speaker, Dr. J. J. Green, Chief of Division (B) Defense Research Board, and Scientific Advisor to the Chief of Air Staff, RCAF, who spoke on the subject of "Research and Development for the Royal Canadian Air Force."

The speaker outlined the history of aeronautical research in Canada, from the first Canadian wind tunnel in 1902, to the present day. He showed the varying emphasis on different phases of research according to the needs of the RCAF at the time. During the early thirties, the RCAF was largely concerned with such aims as aerial photography, forestry, and personnel transport. With the advent of World War II, the emphasis was shifted to air training.

Aviation medicine and human engineering problems gained in importance toward the postwar period.

In the past few years, problems of air defense have been of the greatest concern. The design of radar stations and antiaircraft missiles, as well as the means of controlling the latter, have received full attention.

In particular, problems of arctic navigation, where magnetic compasses are unreliable and radio contacts are limited, and high-speed navigation, where time requirements introduce problems in accurate navigation, are being solved by new air position indicators and course computers.

Operational research has gained stature in the attempt to improve defense planning.

A brief discussion of the paper followed, after which Everett B. Schaefer thanked the speaker on behalf of the Section.

New York Section

Charles Tilgner, Jr., *Secretary*

"Reinforced Plastics in Airplanes" was the title of the symposium held on Tuesday, May 19, at the plant of Grumman Aircraft Engineering Corporation. During the cocktail hour, which started at 7:00 p.m., a demonstration of the Marco method of producing molded laminates was given by Dr. I. E. Muskat. Following this, a 20-min. performance of chorus singing was presented by the Song Sirs from Farmingdale, L.I. Dinner was served starting at 7:45 p.m. As the Tables were being cleared, a demonstration of fixotropic resins was presented by Dr. Muskat, and Mr. Schultz gave a demonstration of the bag-method molding technique.

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Charles Tilgner, Jr., the meeting Chairman, then introduced Alfred W. Russell, President of Russell Reinforced Plastics, of Lindenhurst, N.Y., who acted as Moderator. He first presented the panel, which consisted of the following men: Dr. H. A. Hoppens, Libbey-Owens-Ford Glass Company; Clair Bacon and W. J. Howell, Owens-Corning Fiberglas Company; Dr. Marion Robb, E. I. du Pont de Nemours & Company; Reginald B. Stoops, American Cyanamid Company; Dr. I. E. Muskat, Marco Chemical Company; Dr. William Cummings and Dr. Robert G. Nalb, Naugatuck Chemical; Dr. Elmer Warnken, Cincinnati Testing Laboratory; Frank I. Bennett, Bakelite Division, Union Carbide and Carbon Corporation; Prof. Albert G. H. Dietz, Massachusetts Institute of Technology; Harry J. Friedman and Ernest C. Schultz, Russell Reinforced Plastics Corporation; Samuel S. Olesky, Reinforced Plastic Consultants & Engineers; W. Burdette Wilkins, Consultant; Dr. Paul John Witte, Strux Corporation; Ray Platow, U. S. Plywood Corporation; B. D. Raffel, Goodyear Aircraft Corporation; and William E. Braham, Zenith Plastics Company.

Hiram McCann, Editor of *Modern Plastics*, then gave the only speech of the evening. His talk, which lasted about 20 min., was mainly concerned with the economics of the plastics industry, but much of his material could be applied to other industries.

A unique feature was tried at this meeting. Each of the experts had sent in his paper well in advance of the meeting. These papers were then assembled in a 116-page booklet that was printed and distributed to all who registered for the meeting. At the meeting itself, Mr. Russell asked for questions on the papers, but none of the papers was presented orally. A lively discussion ensued, and it was with regret that the meeting was terminated at 10:45 p.m.

Three hundred and fifteen persons attended the dinner, and approximately 100 people came in after dinner for the technical discussion. The general opinion was that the meeting was highly successful, and it appeared to be a good way of presenting a great deal of information in a short time.

St. Louis Section

Vernon Outman, *Chairman*

The relatively young St. Louis Section recently completed a highly successful meeting season, characterized by a broad range of program material. Meeting topics ranged from aircraft complexity, through airports, atomic energy, to automotive develop-

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ment. Authorities on guided missiles and on convertiplanes and helicopters also spoke to the St. Louis Section.

The season's programs are summarized below:

November 12, 1952—"Complexity vs. Simplicity in the Modern Airplane"; discussion by a panel of engineers and executives from McDonnell Aircraft Corporation, Emerson Electric Company, and Sverdrup & Parcel, Inc.

December 9, 1952—"The Necessity and Requirements for Large Light Metal Forgings for Airplanes," George Papen, Lockheed Aircraft Corporation.

January 22, 1953—"Atomic Energy's Impact on Engineering," Dr. C. Rogers McCullough, Monsanto Chemical Company.

February 25, 1953—"Antiaircraft Defense with Guided Missiles," Henry H. Porter, Applied Physics Laboratory, The Johns Hopkins University.

March 25, 1953—"Army Aviation Today," Col. William B. Bunker, Air Transportation Services Division, U.S. Army, and "Professional Status of the Engineer," John I. Parcel, Sverdrup & Parcel, Inc.; joint meeting IAS and AHS.

April 22, 1953—"The Airport and Its Neighbors," Charles F. Horne, Rear Adm. USN (Ret.) and former Director, CAA; joint meeting IAS and NAA.

May 21, 1953—"Development of the Nash-Healey Sports Car," E. L. Monson, Nash Motor Company; joint meeting of IAS and SAE sections with student members as guests.

▶ **Complexity vs. Simplicity**—In the first of these meetings, held at the Engineer's Club on November 12, a panel of eight McDonnell Aircraft Corporation, Emerson Electric, and Sverdrup & Parcel engineers and executives exhausted the controversial topic, "Complexity vs. Simplicity in the Modern Airplane," before an audience of 150 IAS members and guests. Questions and comments from the floor punctuated the presentations by the panel in a lively atmosphere not dampened noticeably by necessary security restrictions on the information presented and discussed.

Guided by E. M. Flesh as Moderator, the evening's program examined from many angles the dilemma in aircraft- and weapon-design philosophies which arises from the conflicting needs for ever increasing performance, reliability, and safety in aircraft and for low cost, ruggedness, and ease of operation and maintenance.

One of the evening's high points was J. F. Sutherland's humorous call for some means of specification in design of the elusive quality termed "simplicity." In a jocular vein, he offered the unit name, "Simplicitron," for this quantitatively hard-to-pin-down value. Moderator Flesh detailed pungently the growing effects of design complexity; G. S. Graff laid much of this trend at the doorstep of increasingly stiffer requirements for improvements in performance. A. R. Andersen traced the growth of electronic gear in aircraft; R. J. Kern described trends in armament and fire-control systems; and C. J. Wenzinger showed how the capacities of wind-tunnel and related aircraft and missile-development facilities had to be expanded manyfold to accommodate the increasing performance of these weapons. B. G. Bromberg offered a ray of hope that the new science of "Weapons Systems Analysis" will provide a systematic way to establish design requirements for particular weapons. This is done by evaluating mathematically the influence that each design ingredient, such as aircraft, electronic, and armament performance, exerts on the effectiveness of the overall "weapons system" intended to perform a given mission and by indicating the proportions of these various ingredients which will give optimum results.

▶ **Conclusions Reached**—The following general conclusions appeared informally from the evening's discussion:

(1) The military airplane is growing in complexity and weight at an alarming rate. To match World War II aircraft output with designs in existence or projected would cost many times the man-hours and dollars so expended during World War II.

(2) Much of this increase in complexity has arisen inevitably from the race for superior weapons performance. The existence of the atom bomb further stresses the need for aircraft quality, even at the expense of quantity.

(3) The new science of Weapons System Analysis offers a hope of some systematic apportionment of the various design ingredients required to make each weapon the optimum combination for the job.

(4) Each unnecessary pound of weight in frills or dup'ications in design can snowball to 5 to 10 lbs. of weight in the complete aircraft.

(5) The designer of each functional piece that goes into the aircraft, including its controls, power plant, electronics, and armament, must search for and employ the simplest way in which that function can be performed.

▶ **Giant Presses**—In its second meeting, the St. Louis Section heard and discussed a presentation by George Papen, Chief of Production Design at Lockheed Aircraft. Mr. Papen described the Government-sponsored program for procurement of giant hydraulic presses, ranging in capacity up to 50,000 tons of applied force. Mr. Papen outlined the planned applications of these presses in manufacturing large sections of aircraft structures in forged or extruded units, reducing the numbers of parts to be manufactured and joined subsequently by riveting or bolting. Smaller presses now in existence already are being used to forge important structural elements and to extrude others. Illustrations of extruded, integrally stiffened, large skin sections already in use in several Lockheed aircraft were shown by Mr. Papen. Moderator C. F. Marschner and Panel Members W. F. Burke and L. M. Weeks led a lively discussion of the pros and cons of this manufacturing technique for large aircraft sections.

▶ **Wives Join IAS Men at Atomic Energy Talk**—Institute members, their wives, and their guests joined at dinner on January 22 to hear Dr. C. Rogers McCullough, Monsanto Chemical Company executive, talk on "Atomic Energy's Impact on Engineering." This first wholesale entry of the distaff side into St. Louis IAS technical discussions gave many wives of members the opportunity, with their husbands, to hear a preview of things to come in power generation, transportation, and other productive fields through application of the new science of nuclear fission.

▶ **Guided Missiles**—Guided missiles give promise of providing the near-perfect defense now required against attacking bombers, according to the talk given to the St. Louis Section in February by Henry H. Porter.

Mr. Porter, an executive of the Applied Physics Laboratory, The Johns Hopkins University, directs the development of several guided missiles for the U.S. Navy's Bureau of Ordnance at the laboratory. The code name of the project is "Bumblebee," and it is one of the largest such programs in the country.

In discussing the economics of guided missiles versus antiaircraft shells during his talk, "Antiaircraft Defense with Guided Missiles," Mr. Porter pointed out that "since, at the altitudes of expected attacks, guns do not have a high probability of kill per shot, it is not surprising to find that guided missiles will bring down more enemy planes than guns for a given amount of money expended for ammunition. In other words, a stock of guided missiles will shoot down more enemy planes than

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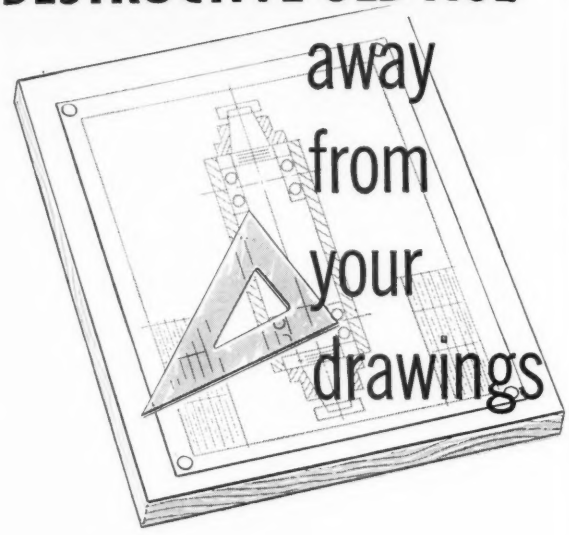

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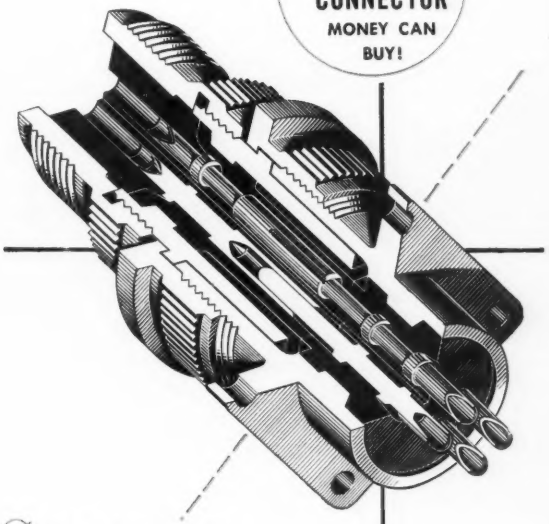

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This Lockheed plant is currently producing big Boeing B-47 bombers for the U.S. Air Force in a cooperative defense effort. Soon the plant will also produce America's first airplane originally designed for turbo-prop power, the Lockheed C-130A cargo transport for the Air Force.

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The C-130A has a floor as strong as a concrete warehouse floor a foot thick. Its fuselage is only 45 inches off the ground—level with truck-bed height for easier loading and unloading. The pressurized cabin permits ground-level comfort for military personnel at high altitudes.

Of special importance to the Air Force, the new transport will require only short take-off and landing runs. Special tandem-wheel tricycle landing gear permits it to use emergency landing fields in forward areas, or even unfinished air strips.

Prototypes of the airplane are nearing completion at Lockheed's Burbank, Calif., plant. The plane will go into quantity production at Lockheed's Georgia Division, in Marietta, where giant B-47 jet bombers are currently being built.

a stock of antiaircraft shells of equivalent cost.

"It is true," he continued, "that in a single heavy attack a far greater cost of guided missiles can be launched than could be expended by an available number of guns. Under these conditions, too, they cost less per plane shot down, and the high cost is a criterion of the very high level of defense. Past experience has indicated that an attrition level of 5 per cent to 10 per cent provided an adequate defense, but now a near-perfect defense is needed. Guided missiles give promise of such a defense."

Mr. Porter also sketched in the pattern of a hypothetical air attack on St. Louis to indicate the manner in which guided-missile antiaircraft weapons could be used in conjunction with fighter interceptor airplanes.

His illustration outlined a "time-and-space" situation where enemy attackers would be detected over Oshkosh, Wis.; the fighters would be alerted when the attackers were over Madison, Wis.; actual interception by the fighters would take place over Rock Island, Ill.; guided-missile sites around St. Louis would be alerted when the bombers reach Peoria; the first antiaircraft missiles launched as the enemy approaches Springfield, Ill.; and the first enemy planes shot down by guided missiles just south of Springfield. Mr. Porter illustrated his talk with a series of slides and motion pictures.

▸ **Army Aviation**—Current developments in Army aviation, as well as what the future may bring in the fields of light observation airplanes, helicopters, and convertiplanes, were discussed by Col. William B. Bunker, Chief of the Air Transportation Services Division, U.S. Army, when he addressed a joint meeting of the St. Louis IAS and AHS Sections in March.

Ranging from a future requirement for a higher performance front-line light plane, suited to adjusting "longer range artillery and guided missiles," to what the development possibilities of the convertiplane may be, Colonel Bunker covered his field thoroughly in a talk entitled, "Army Aviation Today."

"It seems quite probable that the convertiplane aircraft will not be able to replace aircraft in those areas where high performance is a requirement," he predicted. "In the less competitive areas of the transport aircraft and as an assault aircraft, however, the application of this principle should be promising."

Colonel Bunker also sketched in some of the current problems encountered in maintaining and operating

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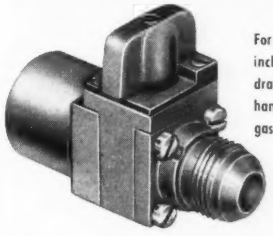

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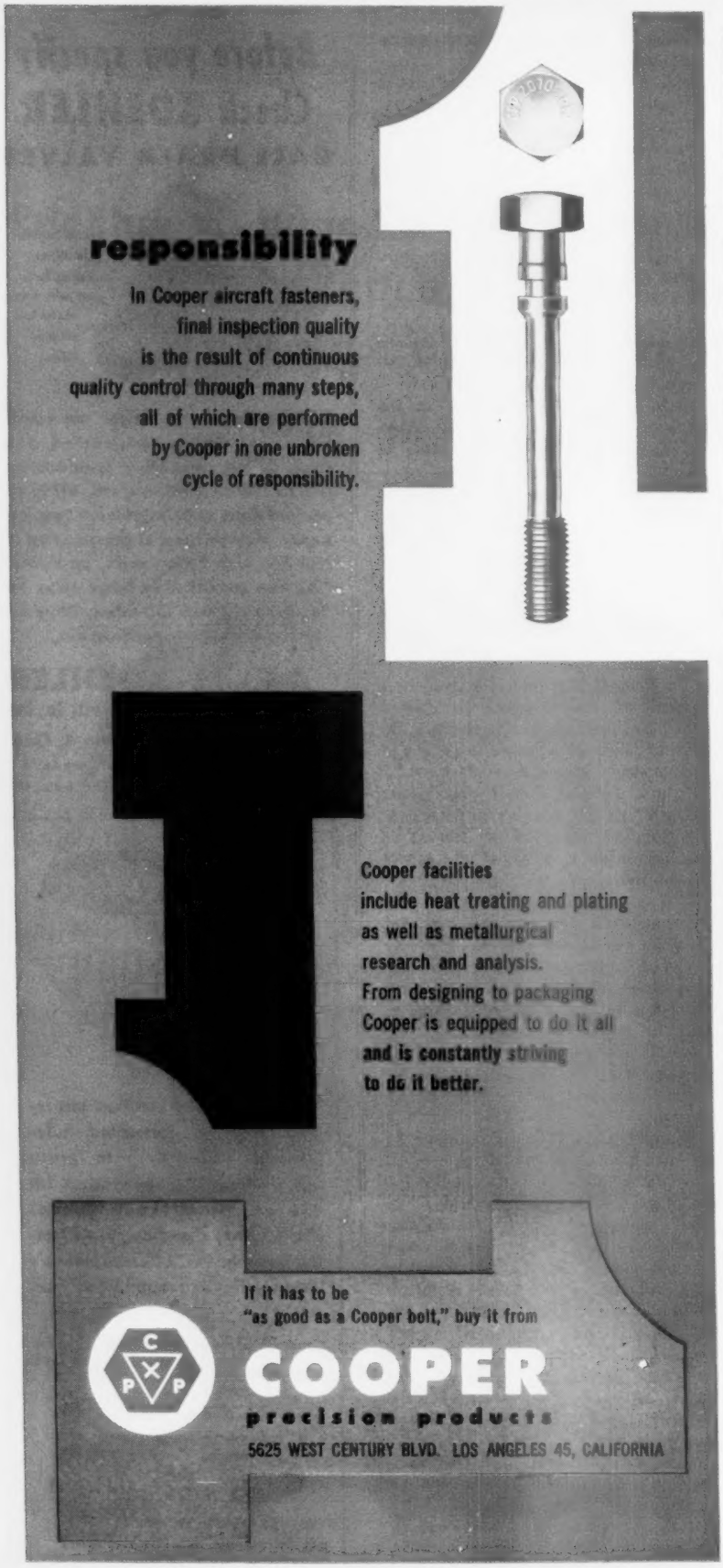
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helicopters in forward areas. He particularly emphasized the tremendous power demands placed on helicopter engines and urged simplicity in design. He pointed out that weight-saving was not as important in the helicopter field if, by the addition of a few pounds, the mechanical dependability of the aircraft were improved.

Stressing the expense of transporting materials to front-line areas ("it costs about $20 per gal. for gas being used at the front"), he concluded with the statement that the Army was looking to the helicopter to supply the mobility that it has lost as a result of greater mechanization that makes its forces heavily dependent on improved and well-maintained highways.

"In Korea," he said, "we are experiencing the same difficulties with mud that faced Napoleon when he was going into Russia 140 years ago."

▶ **Professional Status of the Engineer**—John I. Parcel, Sverdrup & Parcel, Inc., addressed the March meeting also. He reviewed the many technical, social, and economic factors affecting the professional status of the engineer.

▶ **The Airport and Its Neighbors**—Marking the beginning of St. Louis aviation groups' observance of the Golden Anniversary of the Wright Brothers' first flight, Adm. Charles F. Horne, member of the Truman Airport Commission and former Civil Aeronautics Administrator, addressed the local IAS and NAA Sections on April 22.

Admiral Horne reviewed the principal findings of the Truman Airport Commission (best known as the Doolittle Committee), which dealt with the related problems of necessary airport development and of assuring the safety and comfort of those living or working in adjacent areas.

▶ **Student Members Guests of IAS and SAE**—The modern sports car as a problem in development engineering, as well as the focus of a new sporting vogue, was the topic of the last meeting of the 1952–1953 season on May 21. The speaker was E. L. Monson, Chief Development Engineer of the Nash Motor Company, who spoke on "The Nash-Healey Sports Car." The occasion was a joint dinner meeting of the local IAS-SAE groups, with Student Members of both organizations as guests.

▶ **Forthcoming Season**—While formal activities of the St. Louis Section have now recessed for the summer months, Section Chairman Vernon Outman, Program Chairman John Meyer, and their staffs are at work on a program for the coming year. A continued growth is forecast in member participation in St. Louis Section

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San Diego Section

Earl R. Hinz
Corresponding Secretary

The May activities of the San Diego Section ranged from a practice of the art of oscillation to a study of the dynamics of oscillations. On May 2, a successful dance was held in the IAS Building, with music by Francis Leonard's orchestra. Two hundred and twenty members and guests danced from 9:00 p.m. to 1:00 a.m. and enjoyed a buffet supper of generous proportions. Jim Wenzel, Section Treasurer, ably produced this social event of the spring season.

▶ A technical meeting was held on May 21 at which R. W. Streed, Dynamics Engineer of Consolidated Vultee Aircraft Corporation, presented a paper on "The Stability of Hydraulic Control Systems." This topic was well received by the group of 70 present who desired to learn more about the hydraulic systems operating high-speed airplane control surfaces. The factors that affect the stability and response of these systems were described, and methods of obtaining stable operation were presented.

▶ The regular monthly dinner meeting was held on May 28 at the IAS Building. C. H. Smith, Chief Designer of Flight Refueling, Inc., Danbury, Conn., presented an illustrated talk on "Developments in the Hose Method of In-Flight Refueling." Mr. Smith has spent 15 years working on the development of flight refueling methods, originally with the English company of Flight Refuelling, Ltd., and presently with the United States concern. Recent improvements in the hose method of refueling have resulted in high fuel-transfer rates up to 250 gals. per min., with simultaneous refueling of 3 airplanes. The practice of in-flight refueling is considered routine today and can be accomplished with little additional training of receiver airplane pilots. The addition of refueling apparatus to existing airplanes is difficult and costly, because of lack of available space. However, "designed-in" apparatus would penalize an aircraft design only a small amount and would provide an easy and fast ground refueling method.

Jim Adamson, Program Committee Chairman, was also Technical Chairman for this meeting in addition to handling the meeting arrangements.

Seattle Section

Alvin J. Jarvis, *Secretary*

The May meeting of the Seattle Section was held on May 21 in the Engineering Building Theater of Boeing Airplane Company. Attendance was limited to members of the Institute who were cleared for confidential information.

Alexander Satin, Scientific Advisor, Air Branch Office of Naval Research, presented a discussion of recent developments, both classified and unclassified, covering many phases of aircraft and missile design.

Much interest was shown toward Navy-sponsored developments in boundary-layer and circulation control. The discussion was accompanied by slides and was terminated with a movie of the 1952 Farnborough Air Show.

Washington Section

Captain W. C. Fortune, USN
Chairman

The recently announced 1953–1954 Vice-Chairman, William L. Greene, is unable to serve. A. H. Hobelmann, Vice-President, Walter Kidde & Company, Inc., who had been nominated by the recent Nominating Committee for the same position and recommended by Advisory Board members, has accepted the position.

In the absence of J. H. Sidebottom, Col. J. H. Carter, USAF, will serve on the Advisory Board.

IAS Student Branches

Academy of Aeronautics

Ken O'Connor, *Secretary*

The meeting of May 10 was opened by Chairman George Ludwig with 55 students present. After the reading of the minutes of the previous meeting, the various committees gave their reports. Final arrangements for the May 14 field trip to Curtiss-Wright Corporation's Wright Aeronautical Division at Wood-Ridge, N.J., were discussed.

A Boeing Airplane Company film, *Story of the Stratocruiser*, was shown. This film shows, among other things, the extensive tests and data accumulated before this ship was built.

▶ On May 14, 35 members of the Student Branch visited the Wright Aeronautical plant in Wood-Ridge, N.J. Upon our arrival, we were met by Mr. Warrick, Director of Personnel, who supervised our tour; Mr. Matthews, Director of Wages and Adjustments; Mr. Bauer, Engineer; and Mr. Baron, also an Engineer at the plant.

At this point, we signed the Air Force Register, were issued safety glasses, and began our tour of the plant. Our first point of interest was the Pattern Shop where wood and plastic molds are made for the Casting Department. All of the wood patterns are made of solid mahogany and have tolerances of 0.001 in.

Adjacent to the Pattern Shop is the Casting Department. Here, we witnessed the melting of various metals and a short time later saw the pouring of these flaming metals into molds. We then proceeded to the Machine Shop and Assembly Lines.

The high spot of the tour was our witnessing J-65 and Cyclone engines being tested in huge test cells.

We would like to express our gratitude to Mr. Warrick and other members of the Curtiss-Wright staff who helped to make our tour interesting and enjoyable.

▶ On May 24, the final meeting of the month was held with Chairman Ludwig presiding. Plans were made for a field trip to Lakehurst (N.J.) Naval Air Station, where the Navy dirigibles are located. A tour of this base was arranged by the Honorary Chairman, Mr. Firovanti.

A film from Bell Aircraft Corporation on *Planes Without Pilots* was shown. Marvin Greenberg, a Student Member, gave a short talk on the comparison of British and American aircraft manufacturers.

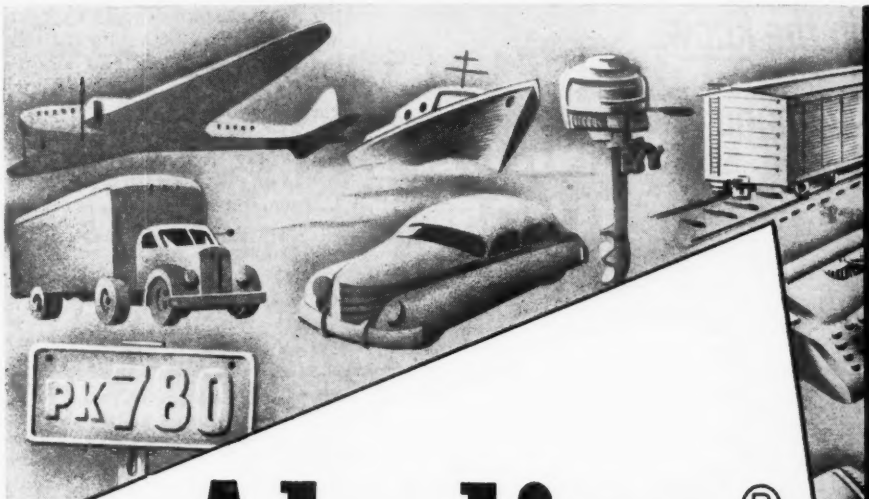
Fifty-five persons were present.

Agricultural & Mechanical College of Texas

R. M. Custer, *Secretary*

The annual barbecue for faculty and student members was held on May 15 with 34 persons attending. It was held at the Brazos County A. & M. Club House.

Faculty Adviser E. E. Brush, speaking on behalf of the faculty members, expressed the faculty's pleasure for having been given the opportunity of working with the graduating class and for the sincerity and cooperation of this class during the past school years. He also commended John Firebaugh, a junior aeronautical engineering student, for his excellent showing at the IAS Texas Section's



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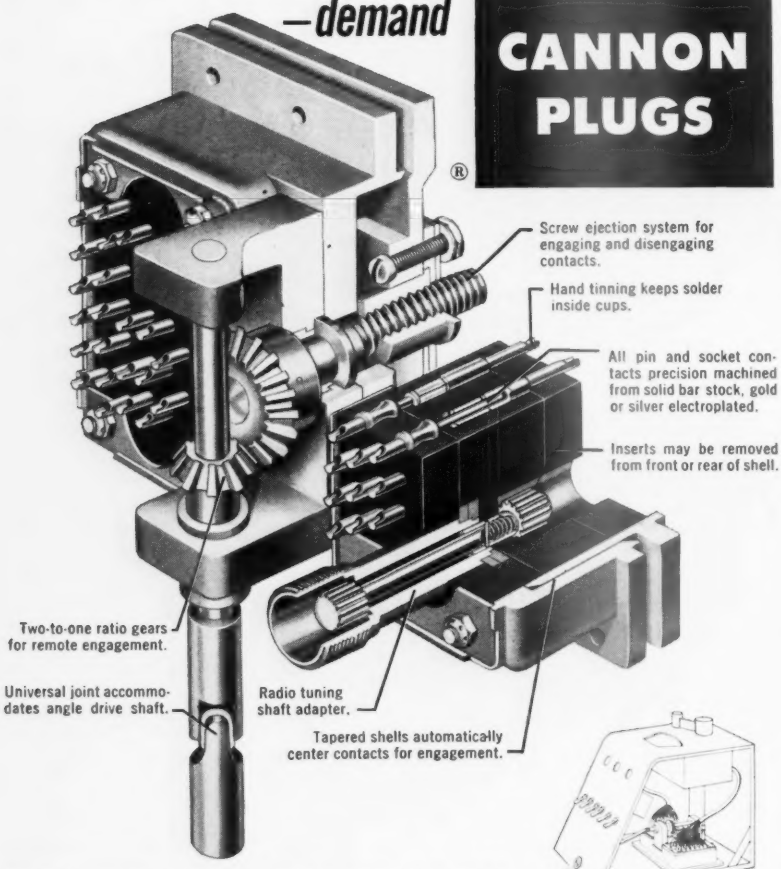
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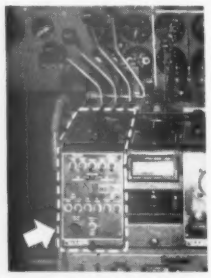
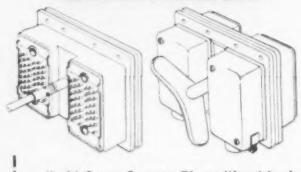
This plug typifies the close attention to important detail that distinguishes every Cannon Plug—the world's most extensive line. If you are looking for real value, regardless of the field you work in, your best bet is Cannon.

Connector is separated by turning slotted shaft here. Complete unit may then be removed from pedestal, shown below.





(Left) Same Cannon Plug without tuning shaft. Straight drive instead of 90° gear. (Right) Similar DPD2 with Dzus wing nut extraction method and junction shells. There are several other variations. Write for details.

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First Southwestern Student Competition. (Mr. Firebaugh won the third prize in the undergraduate division for his paper on "The Nature of Superaerodynamics.")

▶ The final business meeting was held on May 18 in the New Engineering Building with Arthur P. Goldberg, Chairman, presiding. Officers elected for the next year were: Chairman, Dan Palmer; Vice-Chairman, John Firebaugh; and Secretary-Treasurer, Grover Alexander.

Iowa State College

Gary Bowman, *Secretary*

On the evening of May 20, a short business meeting was held. Following this, the men who took part in the First Southwest Student Competition gave a brief review of the contest and also made many suggestions that would help any student who might care to present a paper at another such contest.

▶ At the conclusion of a business meeting on the evening of June 3, two films were shown. These were *The Wonder Jet* and *The Jet Story*.

Refreshments were served at the end of each meeting.

New York University

Paul Lieberman, *Secretary*

The annual elections were held on May 7 with the following results: Chairman, Stanley Smith; Vice-Chairman, Walter Jung; Secretary, Paul Lieberman; and Treasurer, Solomon Metres. Chairman William Zeltner presided; 44 persons attended.

▶ On the evening of May 29, a social was held at the Forest Inn in Queens, N.Y. Thirty-six members were present. At this party, the outgoing officers briefed the newly elected ones in their various responsibilities and turned over to them all of the records, correspondence, and other files.

The Pennsylvania State College

Ralph N. Straley
Secretary-Treasurer

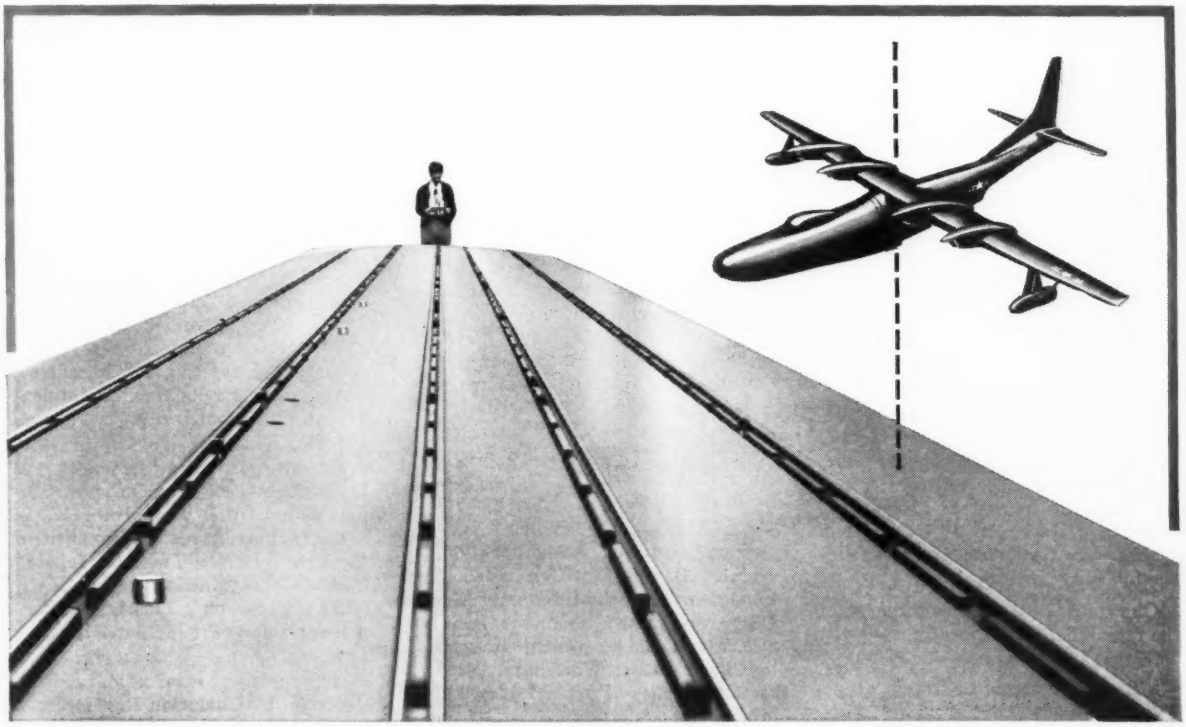
The Pennsylvania State College Student Branch of the IAS held its final meeting of the spring semester on May 13. An unusually small group of about 15 members met in the Main Engineering Building of the Penn State campus. Past Chairman Max Schuster presented the "joy stick," the chairman's traditional scepter, to the new Chairman, Frank Leader, wishing him success in his new post.

Max also gave a report on the picnic held on May 9.

DOW

NAVY'S R3Y-1 FEATURES MAGNESIUM CARGO DECK

"Fastest flying boat" demonstrates extruded magnesium's combination of light weight and toughness for better flooring



MAGNESIUM EXTRUDED CARGO DECK SECTION *of the new Convair-built Navy R3Y-1 "Tradewind" now in production at San Diego. Magnesium provides the R3Y-1 with a tough, yet lightweight, easily installed cargo deck for heavy-duty service.*

In all its 40-year history, water-based aircraft has never been appraised in terms of speed or maneuverability. The big lumbering transports of past years were reputedly slow and cumbersome in flight. This was true primarily because of their great weight.

Today, however, Convair and the U. S. Navy present the "Tradewind" as the fastest flying boat in aviation history. Its turbo-prop engines provide a top speed of more than 350 mph . . . enable it to take off in 30 seconds with full load.

One factor that contributes greatly to the increased speed and easy handling of this giant seaplane is the extensive use of magnesium in its design. Take as an example, the cargo deck. It's made of magnesium ZK60A extrusion alloy. It's light in weight. (Magnesium is the world's lightest structural metal!) And it's strong and rugged enough for heaviest duty. This combination of qualities makes magnesium perfectly suited for this application.

There are other instances, too, in this and in other aircraft, where magnesium has helped designers solve some of their weight and speed problems. Have you considered magnesium for your uses? For more detailed information, contact your nearest Dow sales office, or write directly to THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.

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DOW

Following this report, two films were shown. The first, *Planes Without Pilots*, covered remote control tests and showed the complicated control and indicator units, as well as how these units are used with the rest of the system of the airplane. The second film, *The Avro Jetliner*, presented the equipment and features of the jetliner. It showed flight-testing procedure and ground-check procedure, and gave performance ratings.

The proposed trip to Piasecki has been canceled because recent Naval security enforcements require that tours through the plant be more restricted than heretofore.

Syracuse University

Charles E. Rogers, *Secretary*

The last meeting of the spring semester was opened on May 6 by Chairman Fred Boenig. The minutes of the previous meeting were read and approved.

David Birdseye, of the Ostrander Memorial Plaque Committee, reported that dedication ceremonies will take place within the next few weeks.

Elections, the high note of the meeting, took place with the following results: Honorary Chairman, Joseph Cady; Chairman, David Birdseye; Vice-Chairman, Ernest Hobbs; Secretary, Graham Ireland; and Treasurer, Herbert Byrnes. Vice-Chairman Hobbs is to formulate a program for the fall semester.

Chairman Birdseye took charge of the remainder of the meeting.

University of California

George Lee, *Secretary*

Daniel Tellep and Robert Buckland undergraduate Student Members of the University of California Student Branch, were awarded the first prize of $75 for their paper on "Wind Tunnel Blockage for Nearly Sonic Speeds," presented at the Third Annual West Coast Conference of IAS Student Branches on May 7 at Moffett Field. Their research work was done under the guidance of Professor E. V. Laitone, IAS Faculty Sponsor. Fifteen members of the Berkeley branch attended the tour of the NACA Ames Aeronautical Laboratory at Moffett Field following the paper competition.

▶ On May 16, the student branch held a joint picnic with the student chapter of the American Institute of Industrial Engineers at Berkeley. Twenty student and faculty members were present. The softball game was called a draw in order to start the touch-football game. However, in the preliminary warm-up with the football, the AIIE conceded the game to the IAS when they saw the remarkable control the faculty sponsor exhibited over the prolate spheroid.

University of Illinois

Dwight A. Moberg
Outgoing Secretary

The principal business for the May 20 meeting, the last meeting of the spring semester, was the election of officers for the fall term. The new officers are: Chairman, Frank Vileta; Vice-Chairman, Dwight A. Moberg; Secretary, Dave Herbner; and Treasurer, Jack Burk. The Engineering Council Representative is Bill Russel; Dr. Harry H. Hilton is the Faculty Adviser.

The evening's program consisted of the presentation of speeches by the finalists in the Seminar competition, in which senior aeronautical-engineering students participated. Kenneth C. Kopp gave an engrossing description of the star-tracking control mechanism in his speech on "The Selection of Control Systems for Supersonic Guided Missiles." A comprehensive study of production costs entitled "The Rising Cost of Aircraft Production," was presented by Frank Vileta.

▶ On May 5, the Illinois Student Branch had its Annual Student-Faculty Banquet. After a delicious dinner served at the University Men's Club, the crowd of more than 50 was entertained by speeches presented by Chairman Rex Whitehurst, Master of Ceremonies Fred Mobley, and others.

▶ During the semester, the branch had the full cooperation of the Aeronautical Engineering Department in bringing to the campus speakers from many branches of the industry. Those who spoke at the meetings were: J. W. Braithwaite, Assistant Chief Aerodynamicist, Marquardt Aircraft Company; W. S. Castle, Senior Project Engineer, Advanced Turbo-Jet Design Group, Allison Division, General Motors Corporation; Walter Doll, Pratt & Whitney Aircraft Division, United Aircraft Corporation; Benjamin Pinkel, Chief, Materials and Thermodynamics Research Division, and Assistant Chief, Research, Lewis Flight Propulsion Laboratory, NACA; and W. J. Pitt, Technical Contracts Division, Lockheed Aircraft Corporation.

Members of the Illinois Student Branch would like to take this opportunity to thank these men for participating in our programs. Their speeches have helped to create further interest in our society, in the field of aeronautical engineering, and in the aircraft industry itself.

University of Oklahoma

Ernest Z. Anderson
Secretary-Treasurer

An election of officers was held at the May 26 meeting, at which 10 persons were present and Chairman Lawrence Fred Smith presided. The results of the election are as follows: Chairman, Jack Loewen; Vice-Chairman, Robert Bodner; and Secretary-Treasurer, Ernest Anderson. L. A. Comp is Faculty Adviser and Honorary Chairman.

University of Tulsa

Robert Wolfe
Secretary-Treasurer

The April 16 meeting was called to order by Chairman E. H. Roberts. The minutes of the previous meeting were read and approved. The By-Laws concerning student awards were reviewed, and the election of officers at the May meeting was discussed. Final arrangements for the Student Branch picnic on April 19 were completed.

The two papers presented at the Texas Section's First Southwest Student Competition were given. C. L. Keller delivered his paper entitled "Stalling of Non-Twisted Tapered Wings." This was followed by R. R. Wolfe's paper on "The Desirability of Aircraft Production Illustrations."

The meeting was adjourned at 9:00 p.m. by Chairman Roberts.

▶ The final meeting of the 1952–1953 school year of the Tulsa University Student Branch was called to order on May 21 by the Chairman, E. H. Roberts. The minutes of the last meeting and the treasurer's report were given.

D. A. Lemon, a graduating senior, gave a short and informative talk entitled "Ducted Fans." Mr. Lemon compared the advantages and possibilities of the ducted fan with those of the reciprocating and turbojet types of engines.

The Honorary Chairman, Mr. Klotz, then presented Mr. Lemon with both the student scholarship and student talk awards.

An election of officers for the 1953–1954 academic year was held with the following results: Chairman, Jack Owens; Vice-Chairman, M. A. Ashraf; and Secretary, William Keeler.

The meeting was adjourned at 9:00 p.m. by Chairman Roberts.

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Vickers Model AA-40510 Pump Control Valve. (18 gpm)

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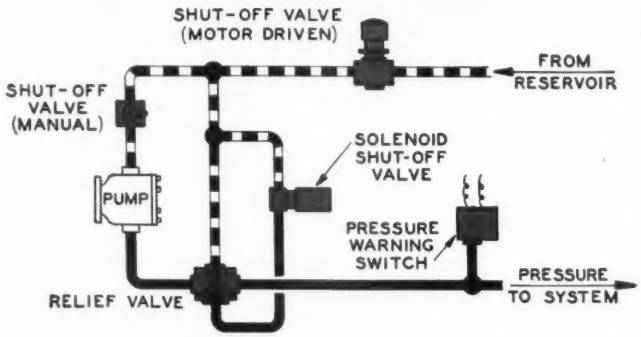
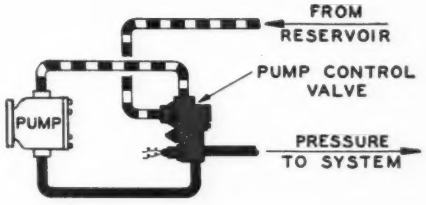


AFTER



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U.S. Naval Postgraduate School

William D. Harkins, *Secretary*

A meeting of the U.S. Naval Postgraduate School Student Branch was held on May 13. Total attendance was 40, and Lt. D. M. Layton, Chairman, presided.

A. M. Mayo, Chief of Equipment and Interior Design, Douglas Aircraft Company, Inc., spoke on "Engineering the Cockpit for the Man." In his lecture, Mr. Mayo indicated the projected thinking that is taking place in the aviation industry toward the day when we will be interested in actual space travel. One of his most interesting speculations was the possibility of filling the human respiratory system with a saline-oxygen fluid to sustain life in outer space. He stated that successful experiments along this line have already been concluded with mice as subjects. Whether the human psychological objection could ever be overcome is problematical.

Various supplementary slides and movies were also shown.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Drucker, Daniel C., Ph.D., Chairman, Division of Engineering, Brown Univ.

Speakman, Edwin A., Gen. Mgr., Fairchild Guided Missiles Div., Fairchild Engine & Airplane Corp. (Wyandanch).

Transferred to Associate Fellow Grade

Edwards, James B., Ch. Engr., Hiller Helicopters, Inc.

Gero, Doane R., M.S.Ae.E., Head, Design Devel., Piloted Aircraft, Goodyear Aircraft Corp.

Lucien, Rene, Ing., E.C.P., Pres., in charge of Engineering, Messier Co.

MacDonough, Edward Paul, B.Sc. in M.E., Ch. of Struct., Chance Vought Aircraft Div., United Aircraft Corp.

Rosenbaum, Robert, M.A. (Physics), Supvr., Dynamics & Loads Group, Airframe & Equip. Br., Civil Aeronautics Administration (Washington, D.C.).

Van Every, Kermit E., M.E. in Aero., Ch., Aerodynamics Sect., Douglas Aircraft Co., Inc. (El Segundo).

Elected to MEMBER Grade

Attinello, John S., M.A.E., Head, Supersonic Aerodynamics Sect., Bureau of Aeronautics, Dept. of the Navy (Washington, D.C.).

Craven, Charles E., M.S.Ae.E., Lt. Comdr., USN; Aircraft Accident Investigator, Maint. & Material Analysis & Research Officer (Norfolk).

Engel, Klaus H. C., M.S. in M.E., Designer, Boeing Airplane Co. (Seattle).

Espy, Melvin P., B.S., Ch., Special Weapons Engrg., Canadair, Ltd.

Gehrkens, George R., Ch. Engr., North American Aviation, Inc. (Columbus).

Guterman, Frederick H., B.S. in M.E., Mgr., Sales Planning, Arma Corp.

Harvie, T. A., B.E.M.E., Devel. Proj. Engr., Canadair, Ltd.

Hodges, Charles W., B.S.M.E., Application Engr., Westinghouse Electric Corp. (Dayton).

Hofeller, Gilbert W., B.S., Sr. Flight Test Engr., Convair (San Diego).

Huyett, Richard C., M.S. in Math., Aerodynamics Engr., Convair (San Diego).

James, Earl E., Jr., B.Sc., Sr. Test Engr., Convair (Ft. Worth).

Katzen, Elliott D., M.S., Aero. Research Scientist GS-12, Ames Aero. Lab., NACA.

Kent, Richard, Jr., Capt., USAF; Asst. Past Instructor, Aircraft Maint. Officer, AFROTC, The Ohio State Univ.

Kerr, John A., B.S.M.E., Sr. Design Group Engr., Power Plants, Convair (Ft. Worth).

Krause, Philip C., M.A. (Math.), Aerodynamicist, Kellett Aircraft Corp.

Kulakowski, L. J., M.Ae., Sr. Aerodynamics Engr., Convair (Ft. Worth).

Logan, Robert D., Jr., Liaison Coordinator, Fairchild Aircraft Div. (Hagerstown).

Mulgrave, Thomas P., B.S.M.E. (Aero.) Aero. Engr. GS-12 (Gen.), NAMC (Philadelphia).

Polk, Edwin H., M.E., Engrg. Specialist, Aircraft Sect., Allstates Engineering Co.

Povejsil, Donald J., M.S.E.E., Engr., Analytical Sect., Devel. Engr., Air Arm Div., Westinghouse Electric Corp. (Baltimore).

Ryan, C. T., Design Group Leader, Canadair, Ltd.

Smith, Emerson W., M.Sc. in M.E., Supvr., Power Plant Test & Devel. Group, North American Aviation, Inc.

Smith, Ronald F. O., Asst. Ch. Designer, Canadair, Ltd.

Sponsel, Clifford W., B.S.C.E., Vice-President, Aircraft Div., American Car & Foundry Co.

Stewart, Warner L., M.S. in A.E., Proj. Engr. (Aero. Research Engr.), Lewis Flight Propulsion Lab., NACA.

Stone, Ralph W., Jr., M. of Ae.E., Asst. to Ch. of Stability & Control Div., NACA, Langley AFB.

Teasdale, Arthur R., Jr., M.S. in E.E., Design Specialist, Aerophysics Group, Convair (Ft. Worth); Member of Graduate Faculty, Electrical Engrg. Dept., Southern Methodist Univ.

Terry, Clifford B., B.S., Gen. Mgr., Electronics Div., Air Associates, Inc.

Thoren, Theodore R., M.S.M.E., Staff Director, Engrg., Research & Devel., Thompson Products, Inc.

Whiteman, Harry H., B.Sc., T-36 Proj. Engr., Canadair, Ltd.

Williams, Edward S., Materials & Process Analyst, Lockheed Aircraft Corp. (Georgia).

Transferred to MEMBER Grade

Barson, Zelmar, M.Sc. in M.E., Fluid Dynamicist, Aircooled Motors, Inc.

Carter, Arthur McDowell, Jr., M.S., Lt. Comdr., USN; Supt., Aero. Materials Lab., NAES, NAMC.

Dettwyler, H. Rudolph, B.S. in Ae.E., Aero. Research Scientist, Propulsion Aerodynamics, Langley Aero. Lab., NACA.

Ford, John C., B.S.Ae.E., Struct. Design Engr., United Aircraft Corp. (Dallas).

Martin, John E., Jr., B.S. in Ae.E., Asst. Supvr., Engrg. Liaison Group, Boeing Airplane Co. (Wichita).

Murray, James G., M.Sc. in M.E., Stress Analysis Engr., Aircraft Engrg. Div., Airframe & Equip. Br., Struct. Group, Civil Aeronautics Administration.

O'Keefe, Charles J., B.A.E., Ch. Aerodynamics Engr., Aerodynamics Sect., Aeromechanics Dept., Missile & Radar Div., Raytheon Mfg. Co.

Turner, David L., B.A.Sc., Stress Engr. Grade II, A. V. Roe Canada, Ltd.

Elected to Associate Member Grade

Craig, John W., Jr., B.S. (Commerce), Asst. Mgr., Engrg. Personnel, Helicopter Div., Bell Aircraft Corp.

Elected to Technical Member Grade

Davidson, Valentine, M.S., Member, Dynamics Sect., Canadair, Ltd.

Dowlen, Edward M., Head, Aerodynamics Sect., Navigational Projects Div., English Electric Co. (Luton).

Faymon, Karl A., M.S.E. (Aero.), Instr., Dept. of Aero. Engrg., Parks College, St. Louis Univ.

Guthrie, Robert J., B.S. in M.E., Design Engr., ARO, Inc. (Tullahoma).

Jarog, Walter J., B.S.Ae.E., Design Engr., Globe Corp., Aircraft Div.

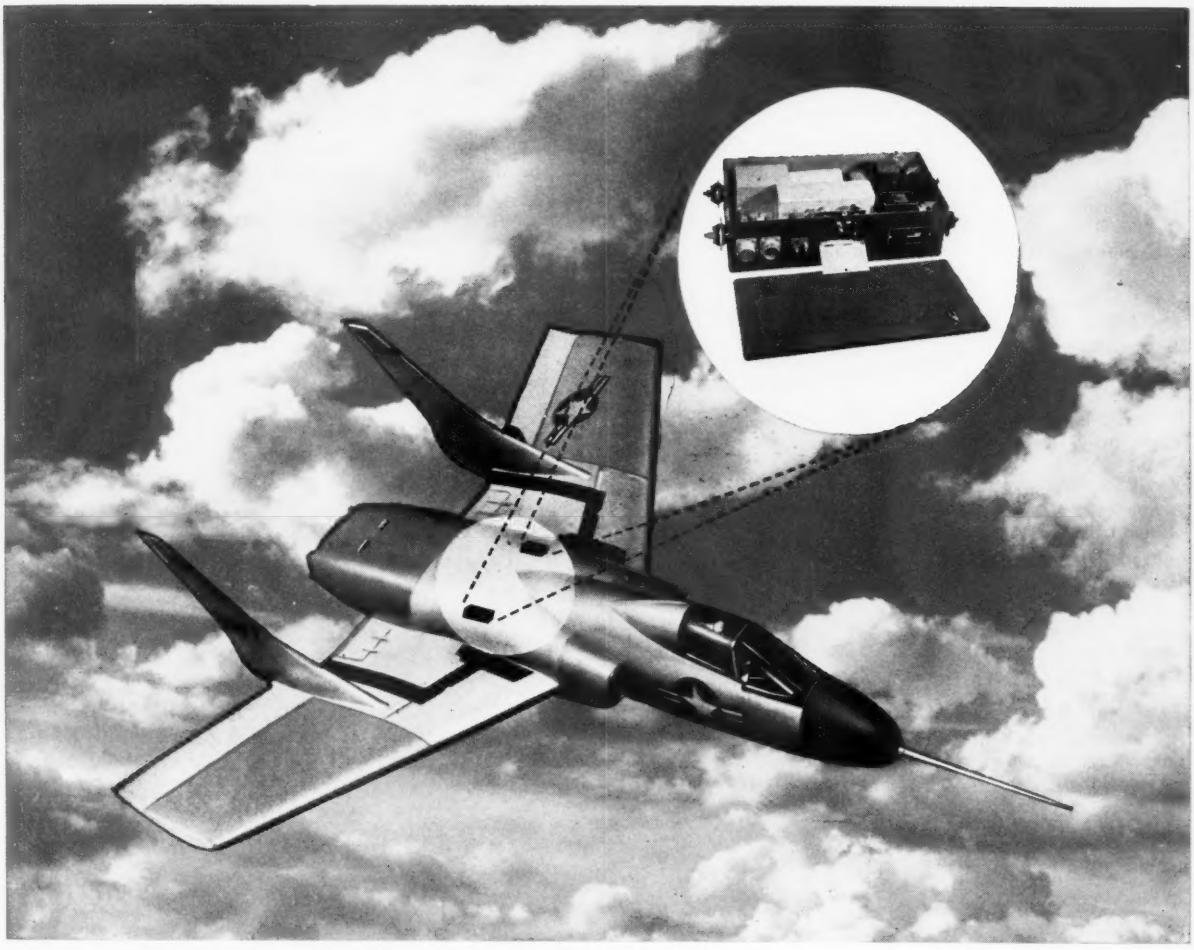
Levine, Philip, B.S.E., Analytical Engr., Melpar, Inc.

Ozkan, Turgut O., M.S., Proj. Engr., Engrg. Dept., M.K.E. Aircraft & Aircraft Engine Factories.

Pinhão, Roberto Ferreira da Silva, 2nd Lt.; Aero. Engr., Helicopter Design Bureau, Ministry of Aeronautics (Rio de Janeiro).

Rapp, Ralph, B.Ae.E., Design Engr. "B," Greer Hydraulics, Inc.

Sullivan, Edward P., B.S. in Ae.E., Aircraft Designer "B," Republic Aviation Corp.



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Transferred to Technical Member Grade

Anderson, Glenn A., B.S.Ae.E., Engr., North American Aviation, Inc.

Berger, Peter, M.E., Physicist GS-9, Corps of Engineers, U.S. Army.

Berkowitz, Herbert.

Blanchard, Thornton, Jr., B.S.A.E., Test Engr., Supersonic Wind Tunnel, Convair (Daingerfield).

Bonior, Raymond V., B. of Ae.E., Pvt., USA.

Breidenstein, Richard M., B. of Ae.E., Aerodynamicist, Bell Aircraft Corp.

Camp, Richard A., B.S.A.E.

Carroll, James B., Sc.B., Research Asst., Research Lab., Brown Univ.

Detra, Ralph W., Dr.Sc., Research Engr., AGT Div., Westinghouse Electric Corp.

Dobson, Wilbur F., B.S.M.E. (Aero), Aero. Research Intern, Lewis Flight Propulsion Lab., NACA.

Eastham, Edmon M., B.S. in Ae.E., Engr.—Wind Tunnel, Univ. of Wichita.

Eilertson, Warren H., B.Ae.E., Jr. Engr., Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Erickson, Earl W., B.Ae.E.

Goldberg, Arthur P., B.S.

Graham, Gordon H., Designer—Structural, Chance Vought Aircraft Div., United Aircraft Corp.

Howard, Weston M., B.S.A.E.

Husmann, Richard A., B.S., Engr., Power Plant Div., Douglas Aircraft Co., Inc. (El Segundo).

Jewell, Jack D., B.S., Research & Devel. Engr., Goodyear Aircraft Corp.

Jordan, James S., B.S. in Engrg., Ens., USN; U.S. Naval Academy (Annapolis).

Kroenke, Irvin M., B.S.M.E., Design & Devel. Engr., Beech Aircraft Corp.

Lange, Gilbert R., B.S. in Ae.E., Exp. Test Engr., Pratt & Whitney Aircraft Div., United Aircraft Corp.

Mack, Robert A., B.M.E., Engr., Hughes Aircraft Co.

Mann, Charles C., M. of Ae.E., Propulsion Engr., Convair (Ft. Worth).

Muka, Joseph A., Jr., B.S., Ens., USN; Instr., Marine Engrg., U.S. Naval Academy (Annapolis).

Mullin, Charles H., B.S., Capt., USAF; Sr. Pilot, Wright-Patterson AFB.

Nicolello, Henry, Engrg. Draftsman, North American Aviation, Inc.

Osborn, Harold E., B.S., 2nd Lt., USAF.

Page, Sanford N., B.S., Aerodynamicist "C," North American Aviation, Inc. (Los Angeles).

Perrin, Louis A., B.S. (Aero.), Sr. Design Engr., McDonnell Aircraft Corp.

Peterson, Norval D., B.S. in Ae.E.

Potter, Edward C., B.M.E., Maint. Engr., Mohawk Airlines, Inc.

Powers, Sidney A., B.Ae.E.

Reynolds, Byron L., B.S.A.E., Engr., Aeronca Mfg. Corp.

Schermerhorn, James R., B.S. in Engrg., Ens., USN; Jr. Officer at Sea, U.S.S. "Jenkins."

Sheldon, Lewis R., Jr., B.S., Test Engr., General Electric Co. (Lynn).

Sibulkin, Merwin, M.S., Physicist GS-11, U.S. Naval Ord. Lab. (Silver Spring).

Stanley, Jerry, Struct. Engr. 1, Stress Analysis, Helicopter Div., Bell Aircraft Corp.

Stohrer, Albert W., B.S., Research Tech. Asst., Willow Run Research Center, Univ. of Michigan.

Sumida, Paul T., B.S. (Aero.), Jr. Engr. "A," Douglas Aircraft Co., Inc. (Santa Monica).

Thomas, Richard G., B.S., 2nd Lt., USAF; Jet Flight Training, J. Connally AFB.

Vinokur, Marcel, B. of Engrg. Physics, Research Asst., Dept. of Aero. Engrg., Princeton Univ.

Vogenitz, Franklin W., B.S.A.E., Asst. in Research, Aircraft Propulsion Lab., Engineering Research Institute, Univ. of Michigan.

Weiss, Leonard, B.Ae.E., Research Asst., Polytechnic Institute of Brooklyn.

Wrieden, Eugene G., B. of Ae.E., 2nd Lt., USAF; Student, Weapons Systems, Massachusetts Institute of Technology.

Attention Members!

All members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*. Responsibility for new developments, awards or honors received, and appointments to new or additional positions are some of the items that your editors believe are of interest to other IAS members. A brief letter or postal card giving exact details will be sufficient. Photographs accompanying news items will be welcomed and will be used where practicable.

Items will be considered on the basis of their timeliness and general interest. Correspondence should be addressed to the News Editor, *Aeronautical Engineering Review*, 2 East 64th Street, New York 21, N.Y.

IAS Twenty-Second Annual Meeting

Authors wishing to have papers considered for presentation at this meeting should submit outlines or short abstracts to the Meetings Committee, 2 East 64th St., New York 21, N.Y., no later than September 15, 1953.

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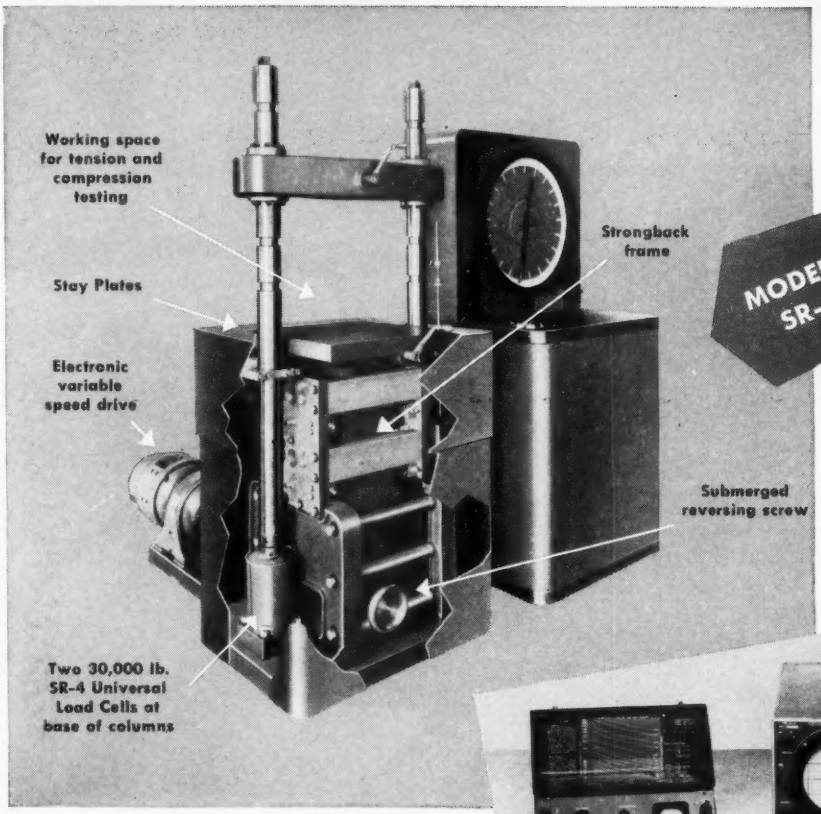
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Submerged reversing screw

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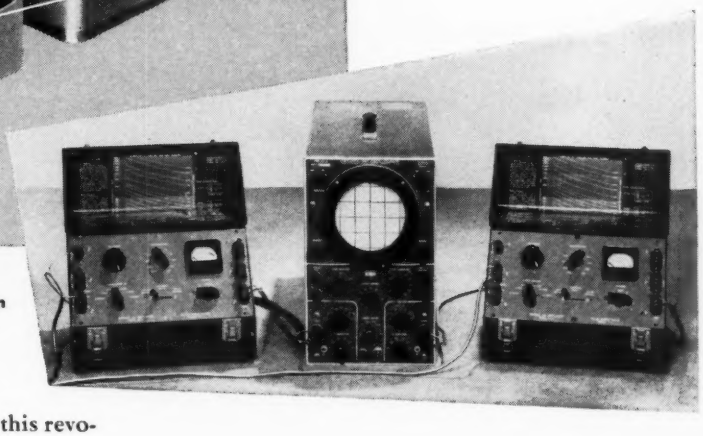

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II. BOOKS REVIEWED IN THIS ISSUE

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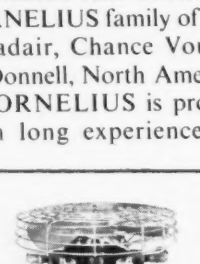

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Aerodynamics

Is There Really a Sound Barrier? Mario A. Pesando and Donald C. Whittley. *Jet Age*, Spring, 1953, p. 1. Aerodynamic flow patterns, the sonic "bang," aircraft performance and control in supersonic flight.

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On Boundary Layers and Upstream Influence. I—A Comparison Between Subsonic and Supersonic Flows. II—Supersonic Flows Without Separation. M. J. Lighthill. *Proc. Royal Soc. (London), Ser. A.*, May 7, 21, 1953, pp. 344; 478. 48 refs.

Review of Published Data on the Effect of Roughness on Transition from Laminar to Turbulent Flow. Hugh L. Dryden. *J. Aero. Sci.*, July, 1953, p. 477.

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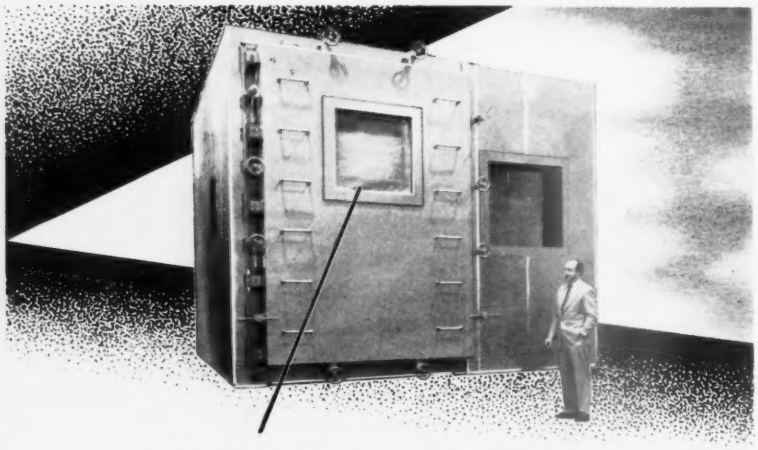

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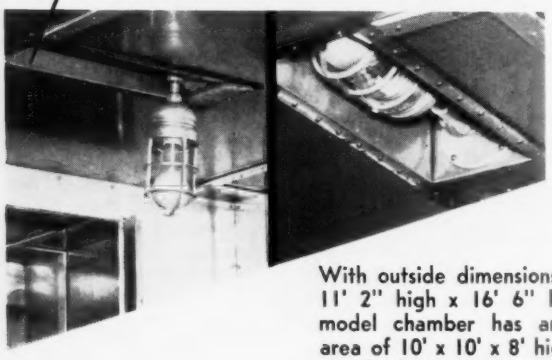

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May 1, 1953. 3 pp. ONR-USAF research project.

Charts of the Wave Drag of Wings at Zero Lift. T. Lawrence. *Gt. Brit., ARC CP 116* (Nov., 1952), 1953. 22 pp. 17 refs. BIS, New York. $0.90.

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Essai de Vibrations au Sol d'une Maquette d'Avion (Ground Vibration Test on a Model Plane). J. Rost. *France, ONERA NT 13*, 1952. 21 pp., folded charts. In French. Wing flutter tests on the Model 861, with new stay-wires and a frequency generator, for the calculation of the fundamental flexure and symmetric torsion.

Gust-Tunnel Investigation to Determine Effects of Center-of-Gravity Position on the Gust Loads of a Delta-Wing Model with Leading Edge Swept Back 60°. Thomas D. Reisert and Domenic J. Maglieri. *U.S., NACA RM L53A30*, June 5, 1953. 13 pp.

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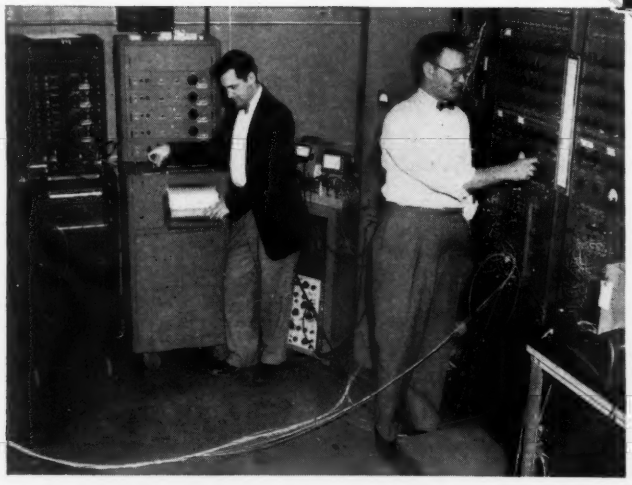

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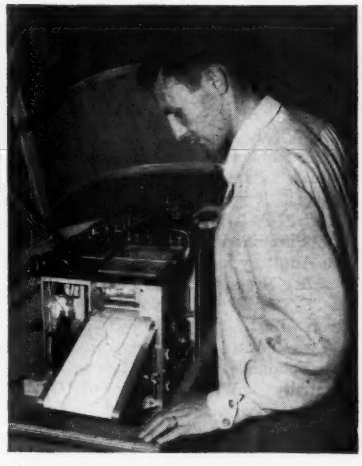

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Operational Aspects of Jet Transport Design. Edward C. Wells. *Aero Dig.*, May, 1953, p. 17. Includes charts and drawings on comparative range, take-off thrust, noise levels, and performance data of various types.

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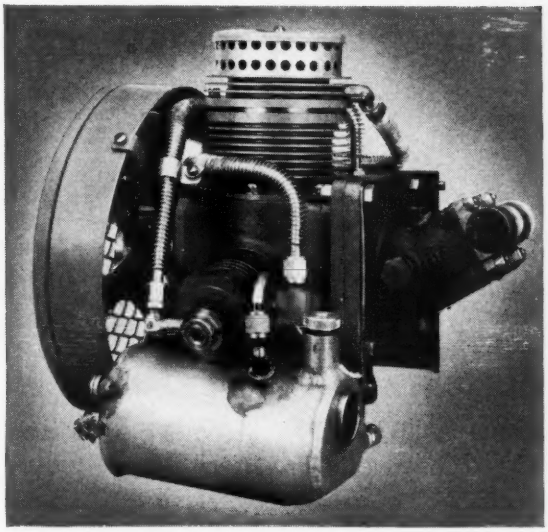
Developed for pneumatically-operated airborne equipment, this lightweight compressor has neither connecting rods, wrist pins nor other complications required by conventional design. Instead, a crankshaft-riding cam simply pushes the pistons into their cylinders. A scotch yoke and sliding rod reverses the first piston while compressed air from preceding stages retracts the others.

For the disc valve in the first stage which is intricately shaped and then heat treated, the design engineers of Walter Kidde & Company, Inc., specified age-hardenable Duranickel. They also called for Duranickel for valve assist springs.

Mechanical Property Ranges of Duranickel

Form and Condition	Tensile Strength 1000 psi	Yield Strength (0.2% offset) 1000 psi	Elongation in 2 in. per cent	Hardness Rockwell C
Rod and Bar				
Hot-finished	90-130	35-90	55-30	75B-22
Hot-finished, age-hardened	160-200	115-150	30-15	32-42
Cold-drawn, as-drawn	110-150	60-130	35-15	90B-32
Cold-drawn, age-hardened	170-210	125-175	25-15	32-42
Strip				
½ hard	130-155		15-3	25-34
½ hard, age-hardened	170-210		20-7	33-42
Spring	155-190		10-2	30-40
Spring, age-hardened	180-230		15-5	36-46
Wire				
Spring	160-200		5-2	
Spring, age-hardened	200-240		10-5	



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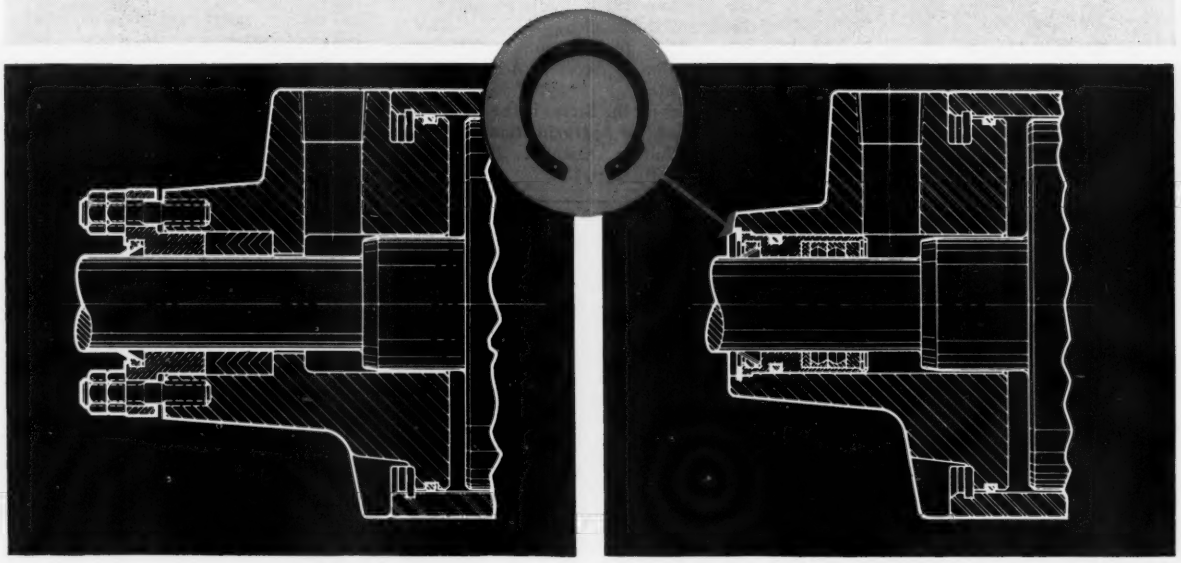

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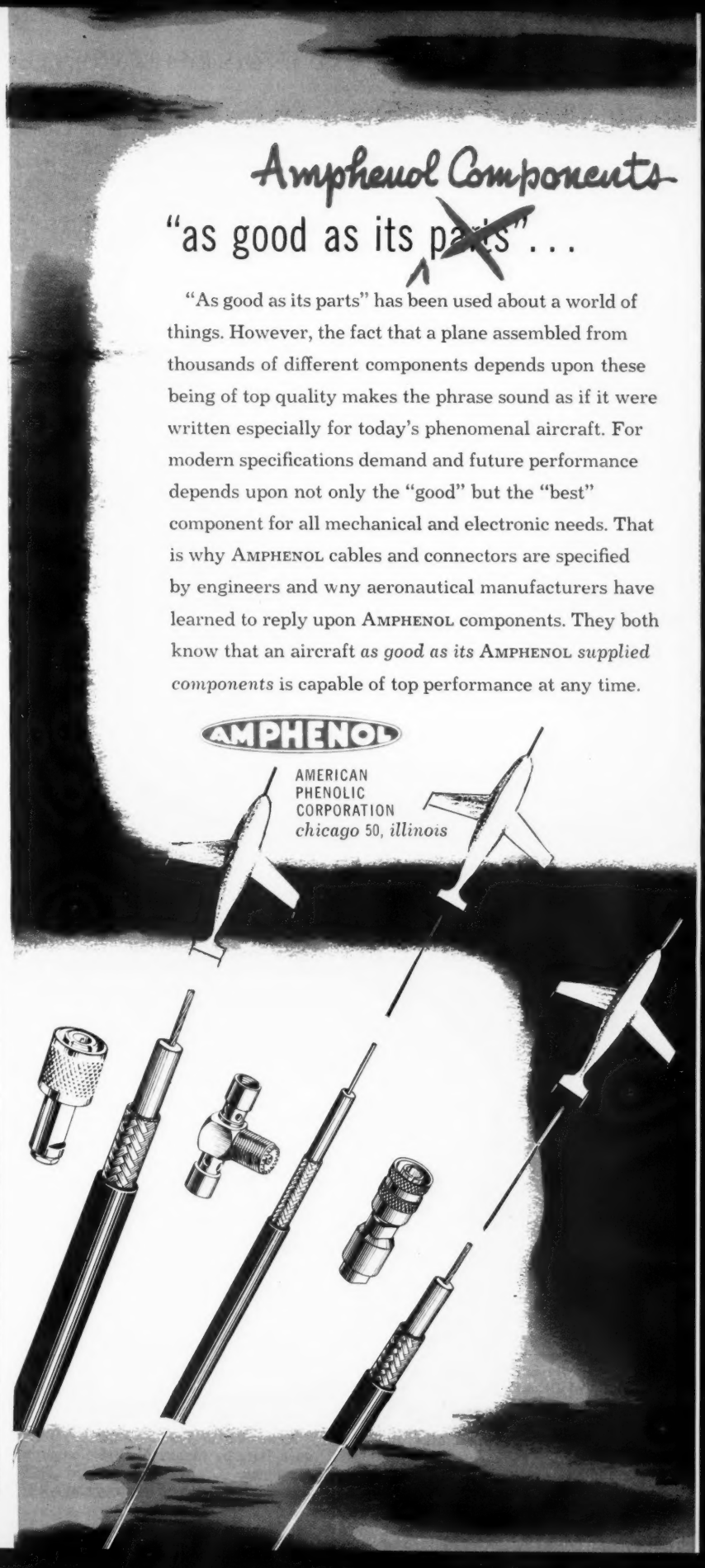
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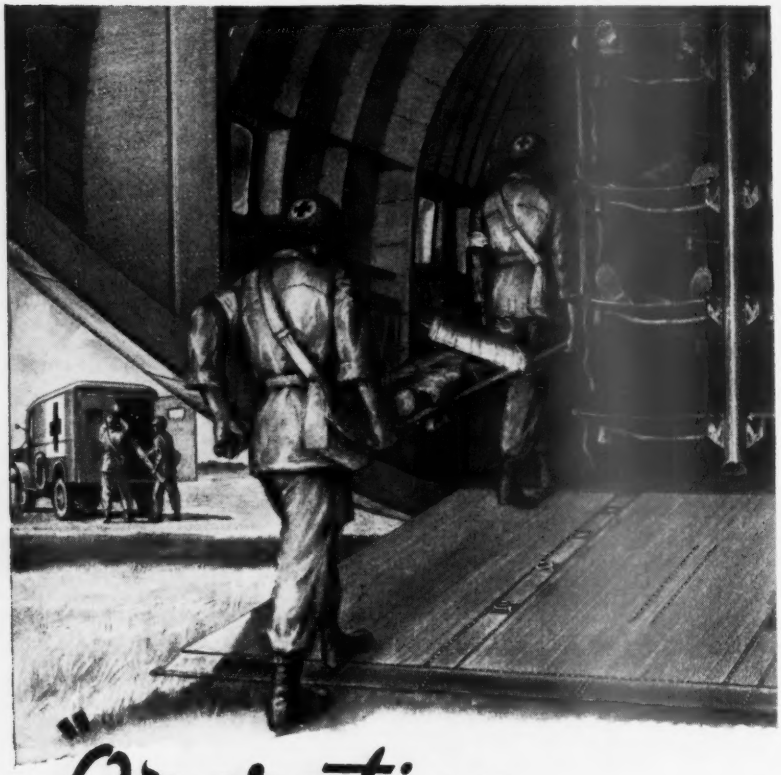

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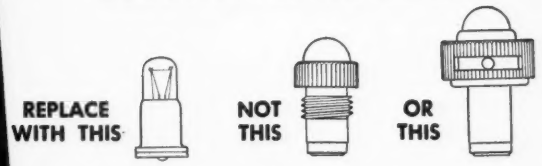

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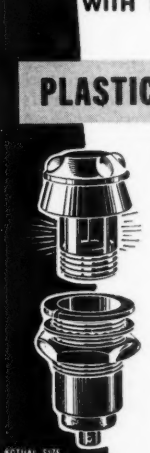

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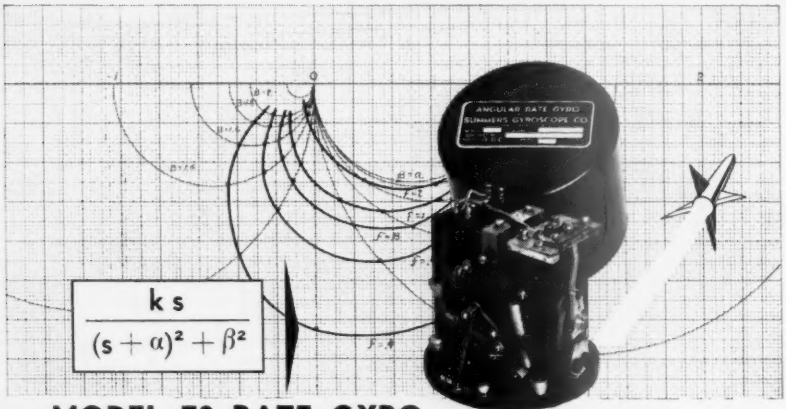

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of the stiffeners leads to failure of the structure.

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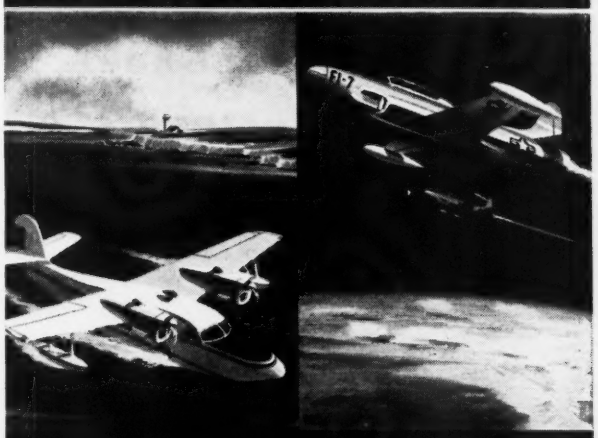

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Aeronautical Reviews — BOOKS

Book Notes

FLIGHT ENGINEERING

Flight Engineers Manual. Charles A. Zweng. 2nd Revised Ed. North Hollywood, Calif., Pan American Navigation Service, 1953. 278 pp., illus., diagrs. figs. $4.00.

This edition has been revised to include current developments and to conform to the latest requirements of the flight engineer's examination. The typical examinations contain multiple-choice questions and answers on the subject matter and also on five specific four-engined transport aircraft. The five aircraft are the Douglas DC-4 and DC-6, the Lockheed Constellation, and the Boeing Stratocruiser and Stratoliner. *Flight Engineers Manual* is designed primarily to prepare students for the written part of the engineer's examination, and to some extent for the oral and practical phases, but it can be used also as a refresher study or general review of flight engineering theory and practice.

MATERIALS

Reinforced Plastics in Airplanes. Preprints of Papers Presented at the New York Section Meeting, Institute of the Aeronautical Sciences, Held at Grumman Aircraft Engineering Corporation, Bethpage, L.I., N.Y., May 19, 1953. Lindenhurst, L.I., N.Y., Russell Reinforced Plastics Corporation, 1953. 116 pp., illus., diagrs. figs.

Contents: Your Industry and Our Industry, Hiram McCann. Fiber Glass Roving, H. A. Hoppens. Glass Fabrics and Handling and Molding of Reinforced Mats and Preforms, Clair Bacon and W. J. Howell. Finishes for Glass Fabrics, Marion Robb. Latest Developments in Polyester Resins, Reginald B. Stoops. Thixotropic Resins, The Marco Method, I. E. Muskat. Polyesters in High Temperature Applications, William Cummings and Robert G. Nalb. High Temperature Phenolics, Elmer Warnken. Molding Compounds Using Glass Phenolic, Frank I. Bennett. Analysis of Stresses in Fiber Reinforced Laminates, Albert G. H. Dietz. Production Techniques in Reinforced Plastics, Harry J. Friedman and Ernest C. Schultz. Radome Engineering and Repairing of Reinforced Plastics, Samuel S. Oleesky. Tooling Techniques for Reinforced Plastics, W. Burdette Wilkins. Expanded Plastics, Paul John Witte. Theoretical and Engineering Concept of Adhesives, Ray Platow. Void Free Laminates and Self Foamed Plastics in Radome Construction, B. D. Raffel. The Trend of Complete Aircraft and Guided Missile Structures Towards Reinforced Plastics, William E. Braham.

Aluminum in Iron and Steel. Samuel L. Case and Kent R. Van Horn. New York, Published for The Engineering Foundation by John Wiley & Sons, Inc., 1953. 478 pp., illus., diagrs., figs. $8.50.

This is the first volume in a monograph series of Alloys of Iron Research which is planned to provide metallurgists and engineers with concise but comprehensive summaries of available data, as reported in the technical literature of the world, on the effect of selected metals on carbon steel and on simple and complex alloy steels and cast irons. The first part of the book contains a summary of data showing the favorable effect of small additions of aluminum to molten steel as a deoxidizer. The second part presents a correlation of data on the effect of aluminum as an alloying element in steel. This part includes chapters on aluminum in heat-resisting alloys, aluminum in permanent-magnet alloys, and the aluminum coating of steel. The bibliography is extensive, containing 341 references. There is a name index and a detailed subject index. Case is Technical Advisor to Battelle Memorial Institute; Van Horn is Director of Research, Aluminum Company of America.

MATHEMATICS

Kernel Functions and Elliptic Differential Equations in Mathematical Physics. Stefan Bergman and M. Schiffer. New York, Academic Press Inc., 1953. 432 pp., figs. $8.00.

The subject of this book is the theory of boundary-value problems in partial differential equations. This theory plays a central role in various fields of pure and applied mathematics, theoretical physics, and engineering. This book discusses a portion of the theory from a unifying point of view and consists of two main parts. The first part gives a survey of boundary-value problems occurring in some branches of theoretical physics—namely, the theory of heat conduction, fluid dynamics, electro- and magnetostatics, and elasticity. The various fundamental solutions are introduced in a heuristic way, and their physical significance is studied. In addition to its own intrinsic interest, the material of this part provides illustrations and exact mathematical formulations of problems and the methods involved. The material in the latter part is divided into chapters dealing with properties of solutions, the kernel functions and their properties, variational and comparison theory, existence theory, and generalizations. The reader is presumed to have a fair acquaintance with the standard methods of analysis provided by such books as those of Courant-Hilbert, Frank-Mises, and Jeffreys. The reference value of the book to the engineer or physicist is augmented by a list of symbols, bibliography, and author and subject indexes.

Stochastic Processes. J. L. Doob. New York, John Wiley & Sons, Inc., 1953. 654 pp., figs. $10.00.

This book is an attempt to fill the need for a standard text dealing with the theory of stochastic processes (namely the mathematical theory of empirical processes whose development is governed by probabilistic laws). Although the book does not cover the subject completely, it does so systematically and extensively. The author provides an introduction dealing with the elementary theorems and definitions of probability and an appendix dealing with measure theory. Some of the subjects treated are processes with mutually independent random variables; processes with mutually uncorrelated or orthogonal random variables; Markov processes—discrete parameter; Markov processes—continuous parameter; martingales; processes with independent increments; processes with orthogonal increments; stationary processes—discrete parameter; stationary processes—continuous parameter; and linear least squares prediction—theory of stationary processes. The author is Professor of Mathematics at the University of Illinois.

MECHANICS

Perturbation Methods in the Quantum Mechanics of n-Electron Systems. E. M. Corson. New York, Hafner Publishing Company, 1951. 308 pp., figs. $11.00.

This book provides a general survey of the methods for studying the properties and behavior of many particle systems. It concentrates on elucidating general principles and methodology and features a detailed treatment of the Dirac vector model and second quantization. Dr. Corson includes a general mathematical introduction and statement of physical principles. He treats physical principles, physical principles of observables, physical representation theory, fundamentals of perturbation theory, group concepts and symmetry properties, the antisymmetry principle, the variation principle and the statistical method, the Dirac vector model, second quantization, the S-matrix theory. Dr. Corson was a member of the Institute for Advanced Study, 1946–1949; Consultant, Brookhaven National Laboratory; and is Research Physicist, Union Carbide and Carbon Research Laboratories.

POWER PLANTS

Elements of Internal-Combustion Engines. A. B. Rogowski. New York, McGraw-Hill Book Company, Inc., 1953. 234 pp., illus., diagrs., figs. $5.50.

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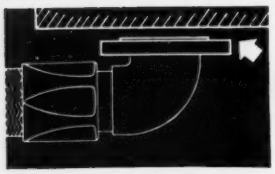

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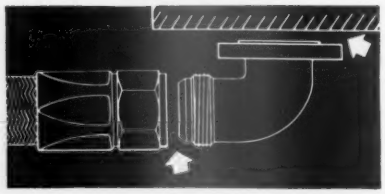

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PRODUCTION

Tool Engineers' Data Book. Gerhard J. Gruen. New York, Reinhold Publishing Corporation, 1953. 219 pp. $5.50.

This reference work is intended not only for tool engineers and designers but also for students of machine and tool design, mechanical engineering, and metallurgy. Tables give standard specifications, physical constants, and chemical, mechanical, and general properties of metals and alloys. Included are data on heat treatment, rapid identification, and working properties of metals and alloys. Two sections are devoted to plastics. Final sections are composed of operational, conversion, and mathematical tables; standard formulas; a glossary of metallurgical terms; and a subject index.

RESEARCH

Teamwork in Research. Edited by George P. Bush and Lowell H. Hattery. Washington, The American University Press, 1953. 191 pp. $4.00.

This volume is adapted from the proceedings of the Third Institute on Administrations of Scientific Research and Development held in Washington, D.C. This Institute was presented by The American University with the cooperation of The National Research Council and The American Association for the Advancement of Science.

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Conclusion: (18) Teamwork in Research: A Commentary and Evaluation, George P. Bush.

Attention Members

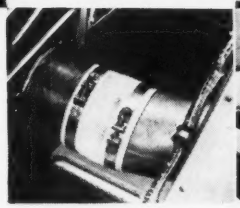
All members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review.*

Each of the 12 vents on the B-36 are wrapped with resistance wire and Silastic R Tape to keep ice from plugging oil vent lines.

Thin layers of Silastic insulate bare resistance wire inside jet intake door panels; conduct deicing heat evenly and rapidly to panel surfaces.

More than 180 limit switches on the B-36 are protected with Silastic boots to assure reliable operation at temperatures ranging from —100° to 170°F.

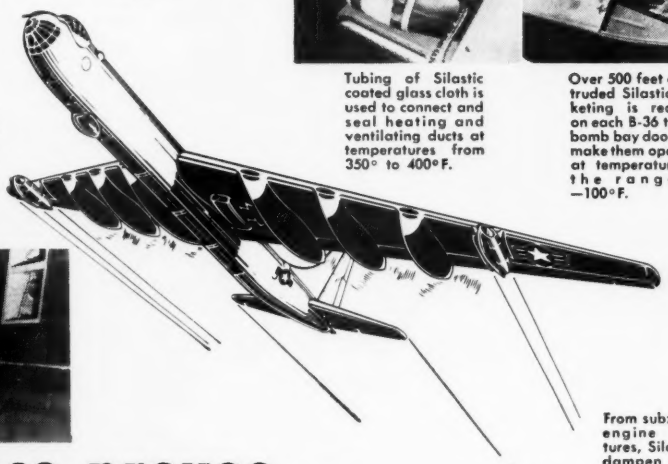
Silastic-coated glass cloth gaskets on the rockerboxes of the P & W engines give long service in contact with oil at temperatures up to 450°F.



Nose turrets are sealed with two 56-inch lengths of cloth-wrapped, sponged Silastic tubing.

Over 300 Silastic flange gaskets in each B-36 seal hot air system at temperatures as high as 400°F.

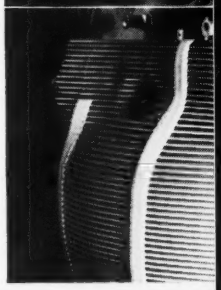
"Orlon" wrapped, sponged Silastic seals prevent air turbulence between flap and engine nacelle; last 10 times as long as materials previously used.



Tubing of Silastic coated glass cloth is used to connect and seal heating and ventilating ducts at temperatures from 350° to 400°F.

Over 500 feet of extruded Silastic gasketing is required on each B-36 to seal bomb bay doors and make them operable at temperatures in the range of —100°F.

Ninety feet of cloth-wrapped, sponged Silastic is used to prevent turbulence and short circuiting of air between leading edge of the flaps and trailing edges of the wings.



From subzero to hot engine temperatures, Silastic strips dampen vibration and prevent breakage of cooling fins on aircraft engine cylinders.

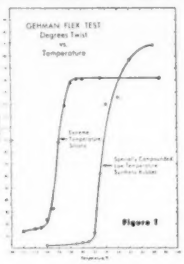
Performance proves...

SILASTIC* works

where other materials fail!

Extreme temperature Silastic stocks are the only rubbery materials that retain their resilience after long exposure to temperatures from —100° to 350°F or after repeated short term exposure to temperatures from —130° to over 500°F. That's why Silastic parts have proved so effective in actual service on the high flying Convair B-36.

The usefulness of rubberlike materials at extremely low temperatures can be established by the recently developed Gehman Flex Test Method (ASTM D1053-52T). Values measured according to this method on an extreme temperature Silastic and a synthetic organic rubber especially compounded for a low temperature service are plotted in Figure 1.



You will note that Silastic does not begin to stiffen until it reaches —50°F, and that it still has a twist value of 13.5 degrees at —130°F. The special low temperature organic rubber loses resilience at +50°F, and will take a twist of only 12 degrees at —22°F.

The usefulness of Silastic on the B-36 is increased by its excellent resistance to oxidation, weathering and to a variety of hot oils. In electrical applications, Silastic stocks are unique even among silicone rubbers for low water absorption and excellent dielectric properties, plus high physical strength.

That kind of performance is typical of Silastic, the Dow Corning silicone rubber. When you need flexibility or good dielectric properties in a resilient material that will withstand years of weathering or long exposure to temperatures far above and below the limits of ordinary rubbers, specify Silastic.

MAIL COUPON TODAY FOR DATA ON THE PROPERTIES OF SILASTIC.

DOW CORNING CORPORATION, Dept. A-8, Midland, Michigan

Please send me:

- ☐ Silastic Facts 10a, properties and applications of Silastic stocks and pastes.
- ☐ List of Silastic Fabricators.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

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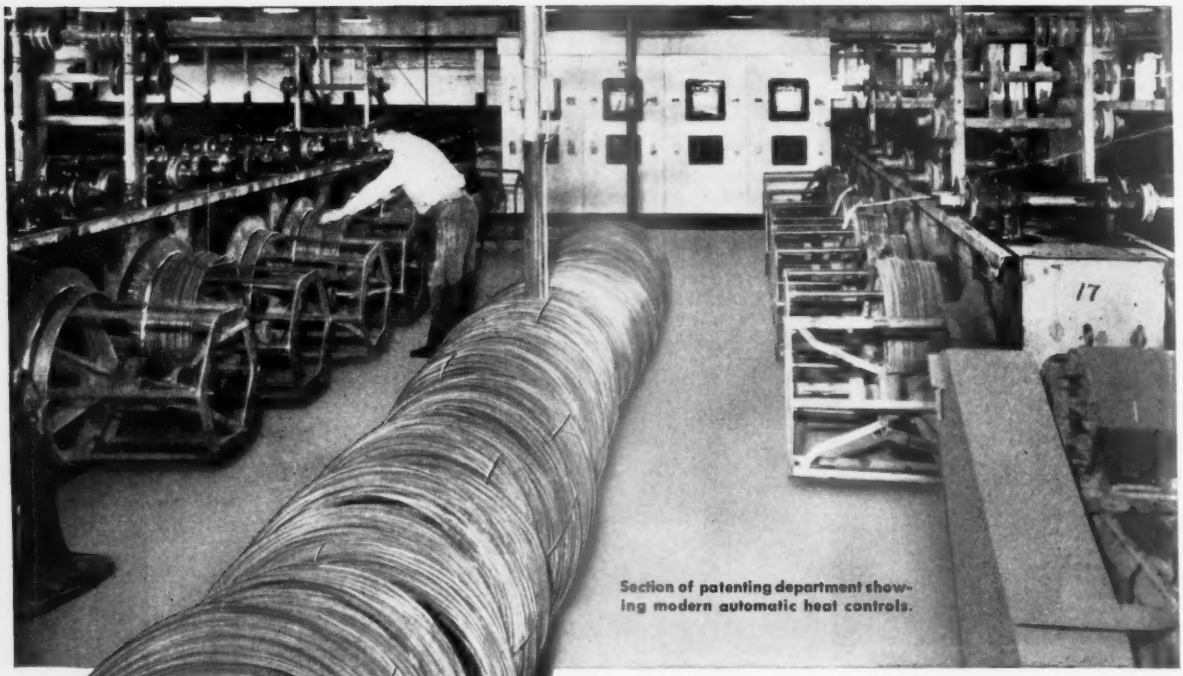
DOW CORNING CORPORATION
Midland, Michigan

These and other B-36 applications for Silastic are more fully described in the March 30, 1953 issue of Aviation Week.

In Canada: Fiberglas Canada Ltd., Toronto In Great Britain: Midland Silicones Ltd., London



Section of patenting department showing modern automatic heat controls.

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Here, all phases of wire processing . . . drawing, cleaning, heat treating, plating, finishing . . . are controlled to a degree and accuracy never exceeded, not often equalled. It's a firmly rooted National-Standard policy that can save you time and money.

Remember, too, another National-Standard policy that can work to your advantage—highly qualified engineering service in the development and application of special wire to solve special problems. As always, it's yours for the asking.

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WORCESTER WIRE WORKS.. *Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Engineers—Unusual opportunities with one of the foremost creative engineering organizations in the United States. Located in central New Jersey. Now expanding in fields of Ordnance, Electromechanical and Electronic Devices, Aircraft and Missile Launchers and Catapults, Compression Distillation, Servomechanisms, etc. Qualifications: B.S. in Engineering, minimum of 3 years in any of the aforementioned fields. Salary commensurate with experience. Address replies to: Personnel Director, Power Generators Limited, 25 N. Montgomery Street, Trenton, N.J.

Engineers—Combine graduate study and employment in research. Educational benefits available while working full time or part time in analytical or experimental thermodynamics, fluid flow, and heat transfer. Project work in analysis of aircraft equipment cooling systems, thermal design, and evaluation of aircraft electronic equipment and rotating electrical machinery. Forward request for additional information with résumé of education and experience (indicating desired field of graduate study and degree) to: W. Robinson, 290 Robinson Laboratory, The Ohio State University, Columbus 10, Ohio.

Professors—Professor Sydney Goldstein, Dean of the Aeronautical Engineering Department of the Israel Institute of Technology in Haifa, Israel, announces openings for two professorships at the Institute: one in the field of aircraft structures, the other in aircraft propulsion or applied aerodynamics. Applicants should have first-rate professional and academic qualifications, be willing to integrate themselves into the life of the country, and, in due course, be able to teach in Hebrew. Applications with full details should be sent, for transmission to Haifa, to the American Technion Society, 1000 Fifth Ave., New York 28, N.Y.

Engineers—Opportunities for employment exist in the Bureau of Aeronautics, Department of the Navy, Washington, D.C. **Electronic Engineer (Radio)**—GS-12, $7,040 per annum. Plan, initiate, and supervise research, design, development, and tests, and recommend engineering action concerning landing aids for naval aircraft. Requirements: 3½ years of professional engineering experience in addition to degree. **Aeronautical Power Plant Research Engineer**—GS-12, $7,040 per annum. Development of general designs and studies of reciprocating, turbojet, turboprop, ram- and pulse-jet, and rocket engines to be used in subsonic and supersonic land and carrier-based aircraft and guided missiles. Requirements: 3½ years of professional engineering experience in addition to degree. **Mechanical Engineer**—GS-12, $7,040 per annum. Responsible for conducting investigations, studies, and projects in gas dynamics. Serves as expert, specialist, and consultant on gas dynamics for the purpose of guiding the development of new naval aircraft power plants. Plans, initiates, and supervises research, design, development, and tests of landing aids. Participates in review and evaluation of design studies made by contractors. Prepares test, installation, performance, and detailed specifications for landing aids and systems. Requirements: 3½ years of professional engineering experience in addition to degree. **Electronic Engineer (Radio)**—GS-12, $7,040 per annum. Interpret present and future military requirements for antisubmarine air-borne radar systems. Analyze existing fleet equipment of this type to determine what improvements can be made to improve their efficiency for meeting operational requirements. Coordinate the research and development programs with other interested services, bureaus, and agencies. Requirements: 3½ years of professional engineering experience in addition to degree. **Aircraft Stability Control Engineer**—GS-12, $7,040 per annum. Plans, initiates, and coordinates guided-missile flight research and flight-research and flight-evaluation programs. Directs and carries out evaluations of the stability and control characteristics of proposed new guided missiles. Prepares specifications pertaining to aerodynamics analyses, especially stability and control of guided missiles. Requirements: 3½ years of professional engineering experience in addition to degree. **Aeronautical Development Engineer (Hydrodynamics)**—GS-11, $5,940 per annum. Under general supervision performs highly specialized aeronautical engineering work in the field of hydrodynamics in connection with design of naval aircraft; assists in model and full-scale research and development projects in hydrodynamics for improvement of seaplane operation. Requirements: 2½ years of professional engineering experience in addition to degree. **Natural Gas Engineer**—GS-11, $5,940 per annum. Devising or examining and approving containers for the storage and transportation of helium. Experience in pressurization and compression systems; knowledge of methods and devices for controlling gases under pressure. Requirements: 2½ years of professional engineering experience in addition to degree. **Mechanical Engineer**—GS-9, $5,060 per annum. Prepares studies and layouts of test facilities for experimental and operational catapults and associated equipment for development of new systems and improvement of existing equipment; prepare preliminary analytical studies of catapulting systems and associated components for launching piloted aircraft to determine theoretical performance characteristics, strength requirements, and optimum configuration. Requirements: 1¼ years of professional engineering experience in addition to degree. **Mechanical Engineer**—GS-9, $5,060 per annum. Prepares preliminary studies to determine the theoretical performance characteristics, strength requirements, and configuration of experimental catapults and associated components. Evaluates design proposals submitted by contractors and Government activities in connection with catapulting equipment to determine conformance with accepted engineering practice. Requirements: 1¼ years of professional engineering experience in addition to degree. **Aircraft Structural Development Engineer**—GS-9, $5,060 per annum. Critical review and analysis of contractor stress calculations consisting of detailed analytical determination of stress tolerances for specific load-carrying structural members. Specification of usable materials for contractor design. Requirements: 1¼ years of professional engineering experience in addition to degree. Applications may be submitted on Standard Form 57, Application for Federal Employment, to the Department of the Navy, Bureau of Aeronautics, Personnel Division, Attention: PE-202, Washington 25, D.C. Standard Form 57 is available at U.S. Post Offices, or may be obtained by writing to the Personnel Division, Bureau of Aeronautics. Visitors to the Washington area may call at Room 3909 of the Main Navy Building, 19th and Constitution Ave., N.W., Washington, D.C.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Engineers, Technologists, Physicists, Physiologists, Metallurgists—The Navy Air Material Center located in the U.S. Naval Base at the extreme south end of Broad Street in Philadelphia, Pa., has vacancies in the above positions for qualified eligibles. These vacancies are at grade GS-5 to GS-12 level with salary ranging from $3,410 to $7,040 per annum. The Naval Air Material Center (the Air Center is divided into three major branches: the Naval Aircraft Factory, the Naval Air Experimental Station, and the Naval Auxiliary Air Station) is engaged in research (applied), development, manufacture, modification, test evaluation, and overhaul of aircraft, aircraft components, and aeronautical materials, including launching and arresting devices. This activity has the job of finding the answers to a never-ending series of problems involving the whole field of aeronautical sciences. Interested persons should file an Application for Federal Employment, Standard Form 57, with the Industrial Relations Department, Naval Air Material Center, Naval Base, Philadelphia 12, Pa. Applications may be obtained from the Industrial Relations Department, Naval Air Material Center, or at any first- or second-class Post Office or from any Civil Service Regional Office.

495. Design Engineer—Instrument Division of a Midwestern manufacturer requires the services of a competent Design Engineer, one qualified to assist and design in diaphragm-type instruments such as Bank and Turn, Rate of Climb, Cabin Pressure Gauges, Airspeed Indicators, and other basic flight instruments. A splendid

opportunity is offered to the individual who has the necessary background and qualifications. Experience along similar lines is essential.

491. Hydraulic Design Engineers—Three to 5 years' experience. Aircraft background desirable. Firm is located within 100 miles of New York City.

486. Design Engineer—An outstanding opportunity is offered in a developmental program by a West Coast company. Applicant should have several years of generalized experience and should have some aerodynamic, as well as structural design, experience. The requirements of the work will involve follow-through from the design to the completed article and supervision of its testing. The applicant should be original in his thinking, preferably with one or more patent applications to his credit. This company, which has 250 employees, presents the advantages inherent in a smaller company for a person to have his abilities recognized by the head of the company, plus the opportunity of more rapid advancement as the company grows.

483. Instructor or Professor—Aeronautical Engineering Department of a large Midwestern University has a position open in its teaching and research staff. Prefers American citizen with Ph.D. degree and some industrial experience to teach aircraft design, structural and stress analysis, and related subjects. Salary and rank depend upon background. Excellent town in which to live. Growing school and department, desires also to expand its research.

Available

497. Sales Engineer—M.S.Aero.E. Age 28; 5 years' experience in aeronautical engineering. Sales engineering position desired by aeronautical engineer. Present position Project Leader. Résumé furnished on request.

496. Mechanical Engineer—Age 32; 8 years' experience in aircraft testing and research on mechanical equipment and structures, including nearly 4 years supervising laboratory and test groups; responsibilities included the planning, scheduling, and supervision of civilian and military test programs. Desires responsible position in aircraft mechanical equipment design or development fields. Complete résumé upon request. Please indicate the nature and salary range of available positions.

494. Aeronautical Engineer—B.S.Ae.E. Desires responsible position in any foreign country for U.S. firm. Varied experience in research, test, production, and management and contract phases of aircraft, missile, reciprocating engines, and rocket power plants. Present position as an Administrative Engineer for aircraft corporation. Married. Age 29. Excellent personal and professional references.

492. Aeronautical Engineer and Technical Writer—M.S. in General Engineering. Over 15 years' diversified general and aeronautical stress and writing experience. Desires teaching position. Prefers New England or California location.

490. Pilot Engineer—B.S. Aeronautical Engineering. Currently employed as Captain for scheduled air line, covering domestic and international routes; 4,500 hours—air line, light plane, and military fighter. Desires responsible position utilizing flight experience with engineering background. Résumé upon request. Age 29, married.

489. Aerodynamicist—Thermodynamicist—Physicist—Graduate M.E. Seven years' experience in supersonic wind-tunnel testing, aerodynamics, and heat transfer. Desires position in supersonic aerodynamic research and development.

488. Pilot—Commercial with all ratings. Qualified DC-3, DC-4, and DC-6 with major airline experience as copilot and flight engineer. Total pilot time 2,700 hours. Total flight engineer time 3,000 hours on DC-6 and B-29. Ground-school instructor ratings in navigation, meteorology, aircraft, aircraft engines, and radio navigation. B.S.Aero.E. degree, age 30. Will relocate.

487. Engineer—B.M.E. and M.S. in Applied Mechanics. Age 30. Nine years' experience in research, development, and design in aircraft and missile fields. Including airflow research in all speed régimes, using various types of equipment; design of mechanical and electronic equipment and instrumentation associated with experimental research and development facilities; and studies of stability, control, and performance problems on aircraft and missiles. Extensive experience with large wind tunnels. Good background in fundamentals of thermodynamics, mechanics, and flows. Supervisory and administrative experience. Desires responsible position in applied research in aeronautical or related field.

485. Representative or Government Contract Administrator—B.A. and M.B.A. degrees. Fourteen years' aviation experience. Sales and Service Manager for prominent aircraft and engine manufacturers. Civilian buyer, Air Force Equipment, Wright Field. World War II production officer, AF Factory Representative, and test pilot. Desires association with aviation division of commercial equipment firm. Opportunity important. Current salary $8,300. Brochure available.

484. Sales Engineer—Seven years' sales and service experience with aircraft components and systems; mechanical and electrical devices to metal and allied industries. Presently employed by leading aircraft equipment company, servicing eastern and middle U.S. air-frame and Government agencies. Married veteran, recently relocated to East Coast.

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Please forward complete resume to:

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Guided Missiles Division

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